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THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,

AND

JAMES D. DANA,

IN CONNECTION WITH

PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK.

LAWRENCE SCIENTIFIC SCHOOL CHEMICAL DEPARTMENT

SECOND SERIES.

VOL. XXXI.—MAY, 1861.

WITH FIVE PLATES AND A MAP.

NEW HAVEN: EDITORS.
1861.

PRINTED BY E. HAYES, 426 CHAPEL ST.

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ERRATA.

P. 210, line 3, for "*Rock*" read "*Rocks.*"—232, line 15 from bottom, *for* "true" *read* "more modern."—237, line 17 from bottom, *for* "forms" *read* "type."—238, 2d l. of note, *after* "No. 1" *insert* "and 2."—242, l. 24 from bottom, in part of edition, *for* "bed" *read* "sea."—242, l. 22 from bottom, in part of edition, *after* "were" *dele* "here."—243, l. 4 from top, *for* "so that" *read* "as, for example."—243, l. 23 from top, *for* "by thorough investigation" *read* "when thoroughly investigated."—243, l. 24 from top, *after* "reveal" *insert* "step by step."—244, l. 18 from bottom, *after* "course" *insert* "in close."—245, l. 7 from top, *for* "West" *read* "this region."—274, l. 14 from top, for "*photomorphosis*" read "*phytomorphosis.*"—275, l. 11 from top, *for* "It" *read* "Grass."—275, l. 25 from top, *for* "flanes" *read* "flancs."—293, l. 11 from bottom, *for* "brocheure" *read* "brochure."—297, l. 16 from top, *for* "gellatinous" *read* "gelatinous."—302, l. 19 from top, *for* "plagairism" *read* "plagiarism," in some copies only.—305, l. 15 from bottom, *for* "brocheure" *read* "brochure."—308, l. 11 from top, *for* "verau-" *read* "Veran-", in some copies only.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

LAWRENCE SCIENTIFIC SCHOOL CHEMICAL DEPARTMENT

ART. I.—*On the Optical Phenomena presented by the "Silver-Spring," in Marion County, Florida;* by JOHN LECONTE, M.D., Prof. of Natural Philosophy in the South Carolina College.*

THE extraordinary reports in relation to the optical phenomena said to be exhibited by the "Silver Spring," induced me, under the invitation and guidance of my hospitable friend, Col. A. G. Summer of Florida, to visit it during the month of December, 1859. And although, as might have been anticipated, many reputed facts vanished under the scrutiny of careful observation, and all its so-called mysterious and wonderful phenomena are obviously referable to well-known physical principles; yet it may be interesting to give a brief statement of them, and to indicate how they may be referred to the recognized laws of physics.

This remarkable "Spring" is situated near the centre of Marion county, in the State of Florida, in latitude (about) 29° 15′ North, and longitude 82° 20′ West. It is about five miles northeast of Ocala, the county seat, and nearly in the axis of the Peninsula, being equally distant from the Atlantic and Gulf coasts. Its waters are discharged by a short stream bearing the same name (viz: "Silver-Spring") which, running about six miles, unites with the Ochlawaha (or Ocklawaha) a tributary of the St. Johns river. The stream takes its origin in a deep pool or head-basin, which is called, *par excellence*, the "Silver Spring." This

* Having been read before the "American Association for the Advancement of Science," at the Newport Meeting, August, 1860.

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basin is nearly circular in shape, about 200 feet in diameter, and is surrounded by hills covered with live-oaks, magnolias, bays, and other gigantic evergreens. The amount of water discharged is so large, that small steamers and barges readily navigate the "Silver Spring" up to the pool or head-spring, where there is a landing for the shipment of cotton, sugar, and other produce. These steamers and barges make regular trips between the Silver Spring and Palatka on the St. Johns. The boatmen informed me that at its junction with the Ochlawaha, more than one half of the water is contributed by the Silver Spring stream. By means of a canoe, I explored the stream for about two miles from its head; its breadth varied from 45 to 100 feet, and its depth, in the shallowest parts, from 10 to 15 feet: the smallest depth measured was not less than 10 feet in the channel of the stream. The average velocity of the stream was rudely estimated at about two miles per hour: at the narrowest portions it was estimated at three miles per hour. According to the reports of the residents, the level of the water of the Spring at the landing is subject to comparatively slight fluctuations, scarcely ever exceeding two feet. These fluctuations of level seem to be connected with the season of rains. The commencement of the rainy season varies from the 15th of June to the 15th of July. The waters of the spring begin to rise about the middle of the season of summer rains, and attain their maximum height about its termination. The maximum depth of water in the pool or basin constituting the head of the silver spring, was found to be not more than 36 feet in the deepest crevice from which the water boils up: the general depth in the central and deep parts of the basin was found to be about 30 feet. These measurements were made by means of a heavy plumb-bob attached to a twine, to which bits of white cloth were secured at intervals of six feet, or one fathom. As the plumb-bob as well as each piece of white cloth indicating the fathoms, could be distinctly seen down to the very bottom, the measurements were of the most satisfactory character. Inasmuch as accurate quantitative determinations, however easily applied, are seldom resorted to by the unscientific, we need not be surprised, that the real depth of this spring falls very far short of its reputed depth. In South Carolina, the reported depth was variously stated at from 120 to 150 feet: on the confines of Florida it was reduced to 80 feet: while the smallest estimate in the vicinity of the spring was 45 feet! This affords an illustration of the general law, that the accuracy of popular statements bears an inverse proportion to the distance from the point of observation: probably, like all emanations from centres, following the law of inverse squares.

Doubtless, the greater portion of the water which flows in the Silver-Spring river is furnished by this principal or head-spring;

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but there are several tributary springs of similar character along the course of the stream, which contribute more less to the volume of water. These usually occur in deep basins, or coves (as they are called), in recesses along the margin of the stream. The depth of one of these coves situated about 200 yards below the head-spring, was found to be 32 feet in the crevice in the limestone bottom from which the water boiled: in other deep parts of the basin, the depth was about 24 feet. The "Boneyard," (so called from the fact that several specimens of the bones of the Mastodon have been taken from it,) situated two miles below the head-spring, is a cove or basin of a similar character. Its maximum depth was found to be 26 feet.

The most remarkable and interesting phenomenon presented by this spring, is the truly extraordinary transparency of the water; in this respect surpassing anything which can be imagined. All of the intrinsic beauties which invest it, as well as the wonderful optical properties which popular reports have ascribed to its waters, are directly or indirectly referable to their almost perfect diaphaniety. On a clear and calm day, after the sun has attained sufficient altitude, the view from the side of a small boat floating on the surface of the water near the centre of the head-spring, is beautiful beyond description, and well calculated to produce a powerful impression upon the imagination. Every feature and configuration of the bottom of this gigantic basin is as distinctly visible as if the water was removed, and the atmosphere substituted in its place!

A large portion of the bottom of this pool is covered with a luxuriant growth of species of water-grass, and gigantic moss-like plants (fresh-water Algæ), which attain a height of 3 or 4 feet. The latter are found in the deepest parts of the basin. Without doubt, the development of so vigorous a vegetation at such depths, is owing to the large amount of solar light which penetrates these waters. Some parts are devoid of vegetation: these are composed of limestone rock and sand, and present a white appearance. The water boils up from fissures in the limestones; these crevices being filled with sand and comminuted limestone, indicate the ascending currents of water by the local milk-like appearance produced by the agitation of their contents. At these points my plumb-bob was observed to bury itself in the mass of boiling sand.

My observations were made about noon, on the 17th and again on the 20th of December, 1859. The sunlight illuminated the sides and bottom of this remarkable pool as brilliantly as if nothing obstructed the light. The shadows of our little boat, of our over hanging heads and hats, of projecting crags and logs, of the surrounding forest, and of the vegetation at the bottom, were distinctly and sharply defined; while the constant waving

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of the slender and delicate moss-like algæ, by means of the currents created by the boiling up of the water, and the swimming of numerous fish above this miniature subaqueous forest, imparted a living reality to the scene which can never be forgotten. And if we add to this picture, already sufficiently striking, that objects beneath the surface of the water, when viewed obliquely, were fringed with the prismatic hues, we shall cease to be surprised at the mysterious phenomena with which vivid imaginations have invested this enchanting spring, as well as at the inaccuracies which have been perpetuated in relation to the wonderful properties of its waters. On a bright day, the beholder seems to be looking down from some lofty airy point on a truly fairy scene in the immense basin beneath him, a scene whose beauty and magical effect is vastly enhanced by the chromatic tints with which it is invested.

Popular opinion has ascribed to these waters remarkable magnifying power. In confirmation of this, it is commonly reported that the "New York Herald" can be read at the bottom of the deepest parts of the pool. It is almost needless to state, that the waters do not possess this magnifying power, that it is only the large capitals, constituting the heading of this paper, which can be read at the bottom, and that the extraordinary transparency of the water is abundantly sufficient to account for all analogous facts. A variety of careful experiments were made with the view of testing this point, by securing printed cards to a brick which was attached to my fathoming-line, and observing at what depth the words could be read when viewed vertically. Of course, when looked at obliquely, the letters were distorted and colored by refraction. Numerous comparative experiments were likewise executed, in relation to the distances at which the same cards could be read in the air. The results of these experiments may be announced in a few words, namely:—That when the letters are of considerable size, say a quarter of an inch or more in length, on a clear and calm day, they could be read at about as great a vertical distance beneath the surface of the water as they could be in the atmosphere! Subsequently, my young friend, Dr. Henry M. Holmes, of "Silver Spring," at my suggestion, repeated several of these experiments, with identical results. In some instances, the cards were read by those who were ignorant of the words on them. The experiments were made on various sized letters, and at depths varying from 6 to 30 feet. The comparative experiments in reading the cards in air and water, serve to convey a more distinct idea of the wonderful diaphanous properties of the latter, than any verbal description.*

* Bouguer, in his *Traité d'Optique sur la graduation de la lumière*, (Paris, 1760.) gives the results of experiments made on sea water with his photometer, by which the loss of light in a column of $3^m{\cdot}11$ (=10·214 feet) of sea water confined in a

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Some persons have thought that there was something mysterious in the fact, that objects beneath the surface of the water, when viewed obliquely, are fringed with prismatic hues. It is unnecessary to remind the physicist, that such a phenomenon is a direct physical consequence of the laws of dispersion of light by refraction. Observation proved that white objects on a dark ground were fringed with blue at the top and orange and red at the bottom; while the color of the fringing was reversed for dark objects on a white ground. This is exactly in accordance with recognized optical principles.* In the present case, the phenomenon is remarkably striking and conspicuous, probably, from two causes: *First*, because the extraordinary transparency of the water rendered subaqueous objects highly luminous; and *Secondly*, because the gigantic evergreens which fringed the pool cut off most of the surface reflection, which would otherwise have impaired the visual impression produced by the more feeble refracted and dispersed light proceeding from the objects. The shadow of the surrounding forest formed a dark background, analogous to the black cloud on which a rainbow is projected.

One of the optical phenomena presented by this spring, at first sight, seemed somewhat paradoxical:—namely, that when looking vertically, the depth of the pool appeared to be exaggerated. This fact was most strikingly and satisfactorily illustrated by the exaggeration of the apparent intervals between the bits of white cloth indicating the fathoms on my sounding-cord. The fathoms near the surface underwent a somewhat greater apparent elongation than those nearer the bottom, but all were exaggerated in length. This phenomenon was observed in all places and under all circumstances, was the same whether viewed with one or both eyes; and presented the same appearance to all observers. The apparent length of the upper fathom was variously estimated at from 8 to 10 feet.

In ordinary cases of considerable obliquity of view, it is a familiar fact, that the water appears to be shallower than it really is, in consequence of the seeming elevation of the bottom produced by refraction. Hence the foregoing facts in relation to the apparent exaggeration of depth, may seem to be inconsistent

prismatic box with plates of polished glass at the ends was in the ratio of 8 : 1 compared with the standard candle in air. As we had occasion to mention in vol. xxx, p. 243, this observer estimated that in sea water, at the depth of 311 French feet, the light of the sun would be equal only to that of the full moon, and at the depth of 679 feet would wholly disappear. Compared with these results the observation of Dr. LeConte on the transparency of Silver Spring appear remarkable, and we hope this excellent observer will take occasion to repeat Bouguer's measurements with the water of Silver Spring, and aided by the improved means of modern research in this department of physics.—Eds.

* Vide Herschel's Treatise on Light, *Encyc. Metrop.*, Article 429.

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with recognized optical principles. But a little reflection will show that when the eye is placed near the surface of the pool, and when we are looking down in a direction approaching the vertical, the only method of estimating its depth is by means of the apparent intervals between intervening objects, as for example, the intervals between the branches of a sunken tree and the bottom, or between the fish and the subaqueous vegetation over which they are swimming, or between the fathom marks on the sounding-line. Now, from well known optical principles, it is obvious that the apparent distance between two objects thus viewed, depends, *caeteris paribus*, on the angle which they subtend at the eye. Thus, for instance, the apparent length of a fathom on the sounding-cord, will depend on the magnitude of the angle made by the rays of light proceeding from the upper and lower bits of cloth which mark the interval. And inasmuch as the rays of light proceeding from the fathom mark which is nearer the surface make a greater angle of incidence than those coming from the mark next below, they must undergo a greater degree of refraction, hence the apparent angle subtended at the eye by the interval in question (one fathom,) is greater than if it had been viewed in the air, and therefore the length seems to be exaggerated.

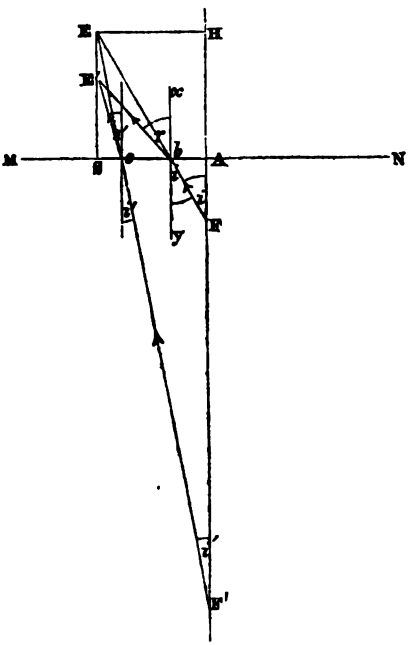
Moreover, as the apparent length of a fathom depends on the angle subtended at the eye, while the degree of refraction is proportional to the sine of the angle of incidence; it follows that when the incidence is large, the augmentation of the angle by refraction will be relatively greater than when it is small. Hence the uppermost fathom should appear to be longer than those below it; this is precisely in conformity with observation. Our estimate of the decrease of these apparent lengths with increasing depth, is doubtless vastly exaggerated by the greater fore-shortening of the lower fathoms. But as all of them seem to be more or less elongated, and as the whole depth is thus —as it were—measured by exaggerated linear units, it must appear to be greater than the reality.

The general result to which these optical laws lead is, that to an observer sitting in a boat in the middle of the pool, the bottom near the margin (if visible at all, for if the angle of incidence is too large, the light from subaqueous objects will be totally reflected, and will not emerge from the water,) will seem to be elevated and the water appear to be shallower than it really is; while the bottom near the centre will seem to be depressed, and the apparent depth exaggerated. In other words, near the margin, the depth is measured by the angle made at the eye by the rays proceeding from submerged objects with those coming from the shore-line; this angle being diminished by the refraction of the former, the depth is apparently diminished. On the

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other hand, when looking directly downwards, we measure the depth by the angle made at the eye by rays emanating from upper and lower submerged objects, this angle being augmented by the greater refraction of the former, the depth is exaggerated. These physical principles thus afford a satisfactory explanation of the peculiar inverted bell-shaped appearance, which the basin presents to an observer floating near its centre. They likewise explain a fact which strikes the most casual observer: namely, that when the boat is advanced toward an apparently shallow spot situated at some distance, it appears to grow deeper as we approach the point in question.

The foregoing is a general physical explanation of the phenomenon of exaggeration of depth; but the principles of optics furnish us with the means of submitting it to a numerical test, and consequently, of showing its adequacy to account for all the facts observed. Following out the graphic method, the validity of the physical explanation was at first tested by construction. While this illustrated in a very satisfactory manner, the accuracy of the deductions which had been drawn, and their entire adequacy to explain all the observed phenomena, at the same time it enabled me to throw the question into a more severe mathematical form. Assuming the surface of the water to be a horizontal plane, and the sounding-line to be vertical, the application of a few elementary principles of geometry and trigonometry will enable us to submit the question to this more rigorous test. In the annexed figure, let M, A, N, be the surface of the water, H, A, F, F′, F″, etc., the sounding-line, E, the position of the eye receiving light from the successive fathom marks, F, F′, F″, etc., assuming no water to be interposed, and E′ the position of the eye receiving the corresponding rays after refraction by the water.



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Let E S=H A $=h$, (the height of E above the water).
" A F $=d$, (the depth of first fathom mark).
" F F′, F′ F″, etc., $=$L, (the length of the fathoms).
" i, i', i'', etc., =the angles of incidence.
" r, r', r'', etc., =the corresponding angles of refraction.
" n =the index of refraction for water=1·336.

From the law of refraction, sin $r=n\times\sin i$, and sin $r'=n\times\sin i'$, etc. By geometry, the angle subtended at E by F F′ $=i-i'$: also the angle at E′ after refraction $=r-r'$. Then by trigonometry we have $\cot i'=\frac{h+d+\mathrm{L}}{(h+d)\times\tan i}$; $\cot i''=\frac{h+d+2\mathrm{L}}{(h+d)\times\tan i}$ etc. Hence it follows, that when h, d, L, and i are given, i' i'' i''', etc., may be calculated, and consequently, r, r', r'', r''', etc., may be found: hence the angle subtended at E by F F′ $(=i-i')$ as well as that subtended at E′ $(=r-r')$ by the same fathom-interval, become known. For the sake of illustrating this point, let us assume $h=2$ feet; $d=1$ foot; L=6 feet; and $i=30°$. Then, by the application of the formula above given, and the geometrical and physical principles already indicated, the following table has been calculated for the foregoing condition of things:

		Angle subtended at E.	Angle subtended at E′.	Ratio of E to E′.
i —30°	r —41° 54′ 46″	By F F′ —19° 6′ 24″	By F F′ —27° 17′ 18″	6 : 8·57
i' —10° 53′ 36″	r' —14° 37′ 28″	" F′ F″ — 4° 18′ 24″	" F′ F″ — 5° 48′ 34″	6 : 8·09
i'' — 6° 35′ 12″	r'' — 8° 48′ 54″	" F″ F‴ — 1° 52′ 18″	" F″ F‴— 2° 30′ 37″	6 : 8·05
i'''— 4° 42′ 54″	r'''— 6° 18′ 17″	" F‴ F⁗ — 1° 2′ 41″	" F‴F⁗— 1° 23′ 56″	6 : 8·03

From this it follows, that, under the assumed conditions, the first fathom-interval is exaggerated in the ratio of 6 to 8·57, whilst the others are elongated in a ratio but slightly greater than 6 to 8. If the angle i (other conditions being the same) had been taken larger, the excess of elongation of the first fathom-interval would have been greater. It thus appears, that all of the fathom-intervals are exaggerated nearly in the ratio of 6 to 8 or 3 to 4:—that is, sensibly in the ratio of the sines of the angles of incidence and refraction for water. This is only true for small angles of incidence, that is, for the lower fathoms; for, in that case, the sines may be considered proportional to the angles. Hence, the real depth of this pool being 36 feet; the apparent depth, assumed to be measured by the exaggerated linear units would be 48 feet.

Strictly speaking, the rays of light emanating from the successive fathom marks, which, under the assumption of no refraction, reach a given point E, would not all after refraction, arrive at the same given point E′: so that, in strictness, the rays of light which enter the eye at E′ are, for the lower fathoms, those which emerge from the water under very slightly different angles of incidence from those given in the table. But it is ob-

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vious, that its influence on the deduced ratio of the angles subtended at E and E', would be wholly inappreciable.

The rigorous solution of this problem in physical optics, involves the application of that refined physico-mathematical reasoning, which has not ceased to exercise the ingenuity of some of the greatest geometers, since the period (in 1682), when Tschirnhausen first called attention to *Caustic Curves*. Sir John Herschel shows, that when the refracting surface is plane, and the refraction is made from a denser into a rarer medium, as from water into air, "the *Diacaustic* curve is the evolute of an ellipse, whose major axis is normal to the plane refracting surface; the radiant point being in the lower focus, while the centre of the ellipse is at the intersection of the major axis with the refracting surface."* In this case, the radiant is a fixed point, and the eye is supposed to view it under all possible angles of emergence. The case which we have under consideration is not materially different. Here the eye is fixed and the radiant consists of a series of equi-distant points descending vertically. In fact, Messrs. Engel and Schellbach, in their admirable *Darstellendende Optik*, have presented us with beautiful graphic representations of the exaggeration and distortion which submerged objects undergo when viewed by the eye placed in various positions above the plane refracting medium.†

Thus, it has been shown, that all of the beautiful optical phenomena presented by the Silver-Spring are referable to recognized physical principles, and that all of the so-called mysteries of its waters vanish under the scrutiny of exact science. It only remains to indicate the causes which produce the extraordinary transparency of the water, upon which, as has been shown, the entire group of phenomena is dependent. It may be remarked, that these diaphanous properties are perennial: they are not in the slightest degree impaired by season, by rain or drought. The comparatively slight fluctuations in the level of the water in the pool, to which allusion has been made, produced by the rainy season, are not, (according to the uniform testimony of the residents), accompanied by any turbidity of its waters. At first sight, it may seem paradoxical that, in a country where semi-tropical summer rains occur, the waters of this stream should not be rendered turbid by the surface drainage. But the whole mystery vanishes, when we consider the peculiar character of the drainage of this section of Florida. Although the surface of the

* *Vide*, Herschel's Treatise on Light. *Encyc. Metrop.* Article 238, Fig. 39.

† *Vide*. Darstellendende Optik, von F. Engel und K. Schellbach. *Halle*, 1856. Taf. 1, Fig. 3 et 4. Under such conditions, submerged objects not only appear to be exaggerated in length, but they seem to be more or less *curved* in the common plane of incidence and refraction, the centre of concavity being towards the observer.

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country is quite undulating or rolling,—the summits of many of the hills being 30 or 40 feet above the adjacent depressions,—yet, there is no surface drainage: there is not a brook, rivulet, branch, or swamp to be found in this part of the State. The whole drainage is subterranean: even the water which falls near the banks of the Silver-Spring passes off by under-ground channels. There is not the slightest doubt, but that all of the rain-water which falls on a large hydrographic basin passes down by subterranean channels, and boils up and finds an outlet to the St. Johns river, by means of the Silver-Spring and the smaller tributary springs which occur in the coves along the margin of the stream. The whole surface of the country in the vicinity of Ocala,—and probably over the area of a circle of 15 miles radius whose centre is the Silver-Spring, is thickly dotted with lime-sinks; which are the points at which the surface water finds entrance to the subterranean passages. New sinks are constantly occurring at the present time. The beautiful miniature lakes,—whose crystal waters are so much admired,—which occur in this portion of Florida, are, doubtless, nothing more than extensive lime-sinks of more ancient date.

Under this aspect of the subject, it is obvious, that all the water which falls on this hydrographic basin boils up in the Silver-Spring, after having been strained, filtered and decolorized in its passage through beds of sand and tortuous under-ground channels. It thus comes out not only entirely free from all mechanically suspended materials, but completely destitute of every trace of organic coloring matter. According to the bargemen there is a striking contrast between the color and transparency of the waters of the Silver-Spring and Ochlawaha at their junction. The latter river drains a country whose drainage is not entirely subterranean. In addition to the above-mentioned conditions, which persistently secure the waters of this Spring from the admixture of insoluble materials as well as from the discoloration of organic matters, it seems highly probable, that the minute quantity of lime which they hold in solution may exercise some influence in augmenting their transparency; for they appear to be more diaphanous than absolutely pure water. There is nothing *a priori* improbable in the idea, that the optical, as well as the other physical properties of the liquid, are altered by the materials held in solution. This is an interesting physico-chemical question which demands experimental investigation. It is proper to add that the waters of the Silver-Spring are not charged with more than the ordinary amount of carbonic acid, they deposit no carbonate of lime; so that, the amount of lime held in solution must be comparatively small.

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Doubtless there are many other springs to be found in the State of Florida, whose waters possess the same optical properties as those of the Silver-Spring; although perhaps, their transparency may be less perfect. The "Suwanee Spring" is said to exhibit analogous phenomena; and the famous fountain situated ten miles from Tallahassee, called Wachulla or Wakulla, is represented as "an immense limestone basin, as yet unfathomed in the centre, with waters as transparent as crystal." Inasmuch as I have not examined these springs, I am unable to say how far the optical phenomena which they present, may be identical with those exhibited by that which is the subject of this paper.

As in some measure related to the peculiar system of subterranean drainage above indicated, it may not be deemed inappropriate to conclude this communication, with a few general remarks, in relation to the physical causes which have produced the several qualities of surface soil, which are found in the neighborhood of Ocala and the Silver-Spring. The whole of this portion of the Peninsula appears to have been originally composed of a mixture of sand and shell-limestone; probably of the Eocene period. The lime-rock comes to the surface, almost everywhere; in some cases, it is composed of nearly pure carbonate of lime; in others, silicification, to a greater or less extent, has taken place by the displacement of the lime by silex. But in all cases where its structure can be made out, it consists of a mass of conglomerated shells. The three grades of fertility at present existing in the soil of this portion of the State, appear to be owing to the greater or less facility with which the lime has been removed from it by aqueous agencies. In the fertile, and densely-wooded Hammock lands, large quantities of soft carbonate of lime may be found at or near the surface. In the Mulatto pine lands, which are extensively cultivated in cotton and Indian corn, the amount of surface carbonate is less abundant; a considerable portion of it having been either silicified or removed from the soil. While in the sterile sandy pine-lands, no lime is to be found: the whole of the rock having disappeared, excepting that which has undergone silicification. In the Hammocks, an impervious substratum of clay has prevented the lime from being carried off by the percolation of meteoric waters;—in the Mulatto lands (so-called because there is a subsoil of yellow clay) the substratum is less impervious, so that, a large portion of the lime has been removed;—while in the Pine barrens, in consequence of the absence of a clay subsoil, the whole of the surface lime has been carried off by subterranean drainage; leaving no surface rocks excepting those which are silicified. According to this view, the light pine lands, which now produce

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cotton with so little labor, are in the transition stage to the pine barrens, and cannot be expected to retain their fertility for any great length of time, unless lime is restored to them by the cultivator. The heavily-timbered Hammocks require a greater outlay to bring them under cultivation; but they constitute the most valuable and enduring lands in this section of the State. Unfortunately they embrace but a comparatively limited area, when contrasted with the space occupied by the pine lands. The outlines of the Hammocks, as indicated by the dense growth of gigantic evergreens, is singularly and sharply defined, either dotting or intersecting the desolate pine-barrens; sometimes forming narrow sinuous verdant bands extending ten or fifteen miles, which, at a distance, remind one of extensive swamps, or the bottom lands bordering a stream.

Columbia, S. C., June, 1860.

ART. II.—*On Nobert's Test Plate and the Striæ of Diatoms;* by W. S. SULLIVANT and T. G. WORMLEY.

THE limit of the resolvability of lines, or how small a space can exist between lines and still admit of their being separated under the microscope, appears to be an undecided point. Prof. Queckett (Treatise on the Microscope, 3d ed., p. 238, 1855) asserts that "no achromatic has yet been made capable of separating lines closer together than the $\frac{1}{75,000}$ of an inch." In the same work, p. 245, it is stated that Mr. Ross found it impossible to ascertain the position of a line nearer than the $\frac{1}{85,000}$ of an inch. We find also on p. 512 that Mr. De Laüe, in his extended examination of Nobert's Test Plates, was unable to resolve any lines closer than the $\frac{1}{87,000}$ of an inch. In Prof. Carpenter's work (The Microscope, 2d ed., p. 189, 1859) this sentence occurs: "the well defined lines on Nobert's Test Plates have not yet been resolved when they have approximated more closely than the $\frac{1}{75,000}$ of an inch."

From the foregoing it appears that actual experiment fixes the limit of resolvability at about $\frac{1}{80,000}$ of an inch: this does not, as is said, vary widely from the deductions of Fraunhofer and others, based on the physical properties of light. In this connection the remark (op. cit. p. 47) of Prof. Carpenter may be cited, "there is good reason to believe that the limit of perfection (in the objective) has now been nearly reached, since everything which seems theoretically possible has been actually accomplished."

On the other hand there are authorities who assert that lines much closer than the $\frac{1}{85,000}$ of an inch are resolvable. A few

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years since Messrs. Harrison and Sollitt published (Microscopical Journal, vol. ii, p. 61, 1854) their measurements of the striæ of several diatoms, assigning to Amphipleura pellucida striæ as close as the $\frac{1}{125,000}$ to $\frac{1}{130,000}$ of an inch. These measurements have recently been repeated, and with exactly the same results, by Mr. Sollitt alone (Mic. Jour., viii, p. 51, 1859) who furthermore expresses the opinion that striæ as close as the $\frac{1}{175,000}$ of an inch can, with proper means, be seen. Mr. Sollitt's measurements have been adopted in the Micrographic Dictionary (1860) and most of the modern works on the Microscope, no one, Prof. Carpenter (op. cit., p. 188) excepted, suggesting a doubt as to their accuracy; on the contrary, their correctness seems to be expressly recognized by Dr. G. C. Wallich (Ann. & Mag. Nat. Hist. for February, 1860).

Such being the conflicting testimony and opinion of distinguished microscopists on the capacity of the modern objective for separating lines, it is somewhat surprising—in veiw of the high state of perfection now attained by the microscope, and of the number of its zealous devotees—that so few experiments have been made, bearing on this interesting point.

As a contribution toward that object, we propose to offer presently an analysis from actual measurements, as far as we were able to carry them, of one of those "marvels of Art," Nobert's Test Plates. In such investigations the quality of the instruments used being all important, we would state that the optical apparatus at our command was ample, consisting of a first-class Smith and Beck microscope stand, a Tolles' $\frac{1}{8}$ objective of 160° angular aperture—an objective of rare excellence in all respects—besides $\frac{1}{15}$ths and $\frac{1}{18}$ths of other eminent opticians, both English and American; also a solid eye-piece micrometer by Tolles, and an improved cobweb micrometer of Grunow's accurate workmanship. Smith and Beck's stage scales furnished the standards for fixing the micrometrical values of the eye-pieces. By means of Tolles' amplifier, an achromatic concavo-convex lens between the objective and the eye-piece, an amplification (by the standard of 10 inches) as high as 6000 times was obtained. This high amplification, with sunlight variously applied after passing through a small achromatic lens of long focus, was effective in resolution, and essential to the distinct counting under the micrometer of the lines of the test plate. The test plate used consisted of 30 bands of lines, each band varying but little from the $\frac{1}{2,000}$ of an inch in width, and having its lines a uniform distance apart. On one end of the plate is engraved by Nobert, in parts of the Paris line, the distance apart of the lines composing the first band, and thence on, the distance between the lines of every fifth band, as in the 2d and 5th columns of the following table.

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Band.	Par. line.	Eng. in.	Band.	Par. line.	Eng. in.
1	0·001000	$\frac{1}{11.248}$	20	0·000167	$\frac{1}{67.413}$
5	0·000550	$\frac{1}{20.471}$	25	0·000143	$\frac{1}{78.737}$
10	0·000275	$\frac{1}{40.943}$	30	0·000125	$\frac{1}{90.074}$
15	0·000200	$\frac{1}{56.297}$			

We add the 3d and 6th columns, giving the distances in parts of the English inch found by multiplying the decimals in the 2d and 5th columns by ·088815.

Analysis of Nobert's Test Plate of 30 *Bands.*

Bands.	Lines in each band.	Parts of an English inch.	Bands.	Lines in each band.	Parts of an English inch.
1	7	$\frac{1}{11.110}$	16	30	$\frac{1}{67.518}$
2	8	$\frac{1}{13.062}$	17	31	$\frac{1}{68.823}$
3	9	$\frac{1}{15.372}$	18	32	$\frac{1}{82.155}$
4	10	$\frac{1}{17.950}$	19	33	$\frac{1}{83.323}$
5	12	$\frac{1}{20.224}$	20	34	$\frac{1}{86.947}$
6	13	$\frac{1}{23.287}$	21	36	$\frac{1}{88.047}$
7	15	$\frac{1}{27.705}$	22	37	$\frac{1}{71.960}$
8	17	$\frac{1}{32.250}$	23	38	$\frac{1}{73.190}$
9	20	$\frac{1}{37.792}$	24	40	$\frac{1}{74.256}$
10	22	$\frac{1}{40.636}$	25	41	$\frac{1}{76.200}$
11	24	$\frac{1}{45.063}$	26	42	$\frac{1}{78.105}$
12	25	$\frac{1}{47.331}$	27	43	$\frac{1}{81.213}$
13	26	$\frac{1}{50.000}$	28	44?	$\frac{1}{83.917}$
14	28	$\frac{1}{52.610}$	29		$\frac{1}{86.334}$
15	29	$\frac{1}{55.900}$	30		

The figures in the 3d and 6th columns, showing the distance apart of the lines in each band, are the mean of numerous and slightly variant trials, particularly on the higher bands. Up to the 26th band there was no serious difficulty in resolving and ascertaining the position of the lines, but on this and the subsequent ones, spectral lines,* that is, lines each composed of two or more real lines, more or less prevailed, showing that the resolving power of the objective was approaching its limit. By a suitable arrangement, however, of the illumination, these spurious lines were separated into the ultimate ones on the whole of the 26th,

* The tendency of lines near the limit, either way, of the objective's resolving power, to run into each other and produce spectral or spurious lines, is readily shown by a low objective on the lower bands. Hence the mere exhibition of lines is not always conclusive evidence of their ultimate resolution. A practiced eye will generally distinguish the false from the true. Recourse to a higher objective often accomplishes the same; but when these fail, the micrometer only, together with a previous knowledge of the actual position of the true lines, can determine whether the lines exhibited are real or spurious. A $\frac{1}{12}$ or $\frac{1}{16}$ will show the 3 or 4 highest bands on this plate regularly and beautifully striped with lines much coarser than the true ones; the same with the $\frac{1}{30}$ on the last band.

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and very nearly on the whole of the 27th band; but on the 28th, and still more on the 29th, they so prevailed, that at no one focal adjustment could more than a portion (a third or a fifth part) of the width of these bands be resolved into the true lines.

The true lines of the 30th band we were unable to see, at least with any degree of certainty, still, from indications, we have no doubt they are ruled as stated by Nobert.

It will be observed that our measurements of the lines on the 1st, 5th, 10th, 15th, 20th, bands vary somewhat from Nobert's registration on the plate as given in the first table above. Such discrepancies are to be expected, and by microscopists familiar with operations of this kind, are looked upon as unavoidable; but that on the 25th band is rather large to be accounted for in this way. We are unable to explain it, and can only say that our repeated measurements of it were very carefully made.

These experiments, together with those of others before noticed, induce us to believe that the limit of the resolvability of lines, in the present state of the objective, is well nigh established; but that this limit may be carried somewhat higher, we are not prepared to doubt, since the handsome advance lately achieved by Mr. Tolles in his $\frac{1}{30}$—combining wide aperture, fine definition, and high amplification—shows that the objective had not, as we were inclined to think, reached the stationary point.

The theoretical view of this question, that is, what may be the closest approximation of lines consistent with their separation under the microscope, we leave to those competent to the task, by whom, it is to be hoped, we may be favored with further information on this point.

With regard to the striation of Diatoms, an opinion generally prevails that the number of striæ on a given portion of a frustule, varies among individuals of the same species, within wide extremes. This opinion is probably traceable in part to one of the earlier publications on the subject, the paper of Messrs. Harrison and Sollitt before referred to, wherein (as in the more recent paper of Mr. Sollitt) measurements of several Diatoms are given showing great variableness in their striation. To these gentlemen much credit is due for their discovery of high markings, before unsuspected, on certain diatomaceous frustules; their measurements however and the alleged variableness of these markings we have not been able to verify, as will be seen by the following extract from our paper published (this Jour., March, 1859,) on this subject.

	Number of striæ in ·001″		
	H. and S.	Sm. Syn.	S. and W.
Navicula rhomboides	60 to 111	85	70
Pleurosigma fasciola	50 to 90	64	52 to 56
Pleurosigma strigosum	40 to 80	44	42
Nitzschia sigmoidea	105	85	70

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Many frustules of these species, from different localities, have been measured by us and always with the same results. Pleurosigma fasciola has been specially designated by Mr. Sollitt, and also by Dr. Wallich, as very inconstant in its markings. Of this diatom we are fortunate in being supplied with abundant specimens, from various localities in England, particularly from the neighborhood of Hull. Several hundred valves, not a few under $\frac{1}{3000}$ of an inch in length, were measured, and on no one were found striæ less than 52 or more than 56 in ·001″, much the larger number being 54. A similarly uniform striation has always been observed among the individuals of many other species examined by us.

To such uniformity of striation Amphipleura pellucida forms as yet no exception; this diatom is still a "res vexata" among microscopists; neither the striation nor the structure of its frustule is at all satisfactorily understood. The record of its striation is found to be thus:—in 1854 Messrs. Harrison and Sollitt's measurements made its striæ 120 to 130 in ·001″;—Prof. Carpenter (1856) first suggests the probability of some error in these measurements;—the writers of this paper declared themselves (this Jour., March, 1859) unable to "glimpse" the striæ;—Mr. Sollitt (Mic. Jour., Oct. 1859) measures them again and finds them still as low as 120 to 130 in ·001″, but gives it as the opinion of Mr. Lobb that "even those figures are too low and that they ought to be set down at 140 in ·001″;"—in the same number of the Microscopic Journal, Mr. Rylands sees "striæ, but much more distant than the 130 in ·001″ of the Hull microscopists;"—lastly Mr. Hendry states (Mic. Jour., July, 1860) that he has "come to a satisfactory conclusion, that it is a sad misrepresentation to set down the lines so high in the scale as 130 in ·001″, and that on a few shells lines may be counted at 42, and many at 60, 70 and 80 in ·001″." A perplexing record, truly!—reminding one of the celebrated Torbane Hill coal case (Mic. Jour., ii, p. 64).

It is our impression, notwithstanding these conflicting statements, that the diatom before us presented to all these gentlemen the same appearances, but their interpretation of these appearances have been widely different.

The testimony of our objectives, as we understand it, seems to indicate that this diatom has a minutely and irregularly broken up surface, which even on the *same valve*, can be made to show an apparent striation, varying from moderately coarse to extremely fine, according to the obliquity or intensity of the illumination, and to the grade, whether low or high, of the objective used, thus proving beyond question that the exhibition is illusory. In numerous trials, particularly on fine English specimens from Hull, sent us by Mr. G. Norman, we have entirely failed, with glasses too of unsurpassed excellence, to bring out,

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regular, *distinct* and *unmistakable* striæ such as would be, at once, so recognized by an eye practiced on the striæ of other diatoms.

After all, it is not improbable, that true striæ yet unresolved, may exist on the valves of this species, and furthermore, that the apparent striæ of different observers may be similar to the spectral or spurious lines before noted as occurring on the bands of Nobert's Test Plate, when examined by an objective incapable of resolving them.

A summary of the foregoing may be briefly stated thus:—that our experiments lead us to believe

1st. That lines on Nobert's Test Plate, closer together than about the $\frac{1}{87000}$ of an inch, cannot be separated by the modern objective.

2d. That no *true* striæ have yet been seen on the valves of Amphipleura pellucida.

3d. That the alleged variableness in the striation of diatoms among individuals of the *same* species has been greatly exaggerated: on the contrary, we find a remarkable uniformity, thus sustaining the opinion of Prof. Smith (Synop. Br. Diat., v. 2, Introd., p. 26) that for characterizing species "striation is the best guide."

Columbus, Ohio, Nov., 1860.

ART. III.—*On the Track of an Animal lately found in the Potsdam Formation;* by Sir W. E. LOGAN, F.R.S.*

(Read before the Natural History Society of Montreal, June, 1860.)

THE Potsdam sandstone is recognized in Canada and New York as the base of the Lower Silurian series. As far as we are certain of the formation in the province it rests unconformably upon the Laurentian series; but on the north shore of Lake Huron, the Huronian series supports unconformably a sandstone which has been supposed to be Potsdam; as no fossils, however, have been met with in it there, its equivalence is somewhat doubtful, particularly as the superior fossiliferous rock into which it passes, appears to be of the Bird's-eye and Black River group.

Mr. Barrande in a paper communicated to the Geological Society of France about a year ago, compares the Potsdam formation with the Primordial Zone, and appears disposed to unite it with the strata marked by *Paradoxides* near Boston in Massachusetts, and Placentia Bay in Newfoundland, the first locality yielding *Paradoxides Harlani* which he identifies with his *P. spinosus*, and the latter Mr. Salter's *P. Bennetii*, and probably other allied genera and species. But while no well ascertained Primordial spe-

* From the Canadian Naturalist, Aug. 1860.

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cies have been met with in the Potsdam of Canada and New York, the formation appears in Canada to be rather allied to the strata above than those below it.*

In the Potsdam of Canada and New York, independent of fucoids, the number of species of which the forms have been either wholly or partially preserved is only three. Two of them are *Lingulæ*, named by Hall *L. prima*, and *L. antiqua;* and while these so far resemble one another that they might by some palæontologists be considered varieties of one species, we in Canada have a *Lingula* (*L. Belli* of Billings,) in the Chazy, which might almost be considered another variety of the same species, the peculiarity of them all being the length and sharpness of the beak. In Canada there is also found in the Potsdam, the impression of the spire of a large flat *Pleurotomaria*, which so strongly resembles the spire of *P. Laurentiana* (Billings) of the Calciferous, that they can scarcely be distinguished. In addition to these upward affinities in the only preserved form, there are beds of passage between the Potsdam and Calciferous formations, in which the strongly marked distinctive lithological characters of the two are well preserved, and at St. Timothy on the Beauharnois Canal those beds of the inter-stratification which are allied to the lower rock are occasionally marked by *Scolithus linearis* (Hall), supposed to be ancient worm-holes, by which the Potsdam is characterised in many parts.

Immediately beneath these beds of passage are the celebrated foot prints of Beauharnois, to which Professor Owen has given the name of *Protichnites*. Since these were described by Owen, nothing has been discovered to throw further light upon the forms of the animals which made these impressions; but in thinning a large specimen with some of the tracks on it, for the purpose of placing it in the museum of the Geological Survey, it was ascertained that the surface on which the traces were impressed must have been subject to the ebb and flow of a tide. The surface on which the tracks are impressed and the one immediately beneath, shew ripple-mark; the next in succession which is about an eighth of an inch below, shews wind-mark, in a number of sharp and straight parallel ridges from two to four inches long and an eighth or a quarter of an inch wide. These characterize a considerable surface, and are precisely similar to the marks so familiar to every person who has examined blown sand. The surface must thus have been alternately wet and dry, and the organic remains of the formation being marine, we have thus pretty clear evidence of a tide.

Proverbially unstable as water is, the mean level of the sea, that is the point which is half-way between high and low water,

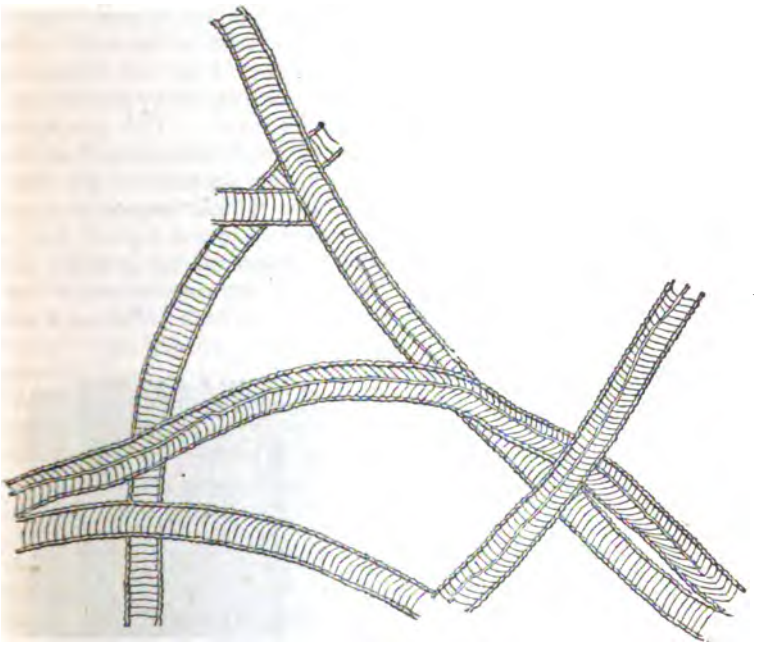
* Since this paper was read two species of *Orthoceras* and an *Ophileta* have been discovered in Canada associated with *Lingula antiqua*, in the Potsdam Sandstone. The trilobite *Conocephalites minutus* (Bradley) has also been since described.

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is supposed to be the least changeable level on the face of the globe, and taking it to be now pretty much as it was during the Lower Silurian period, we establish the means of knowing approximately how much the position where the tracks are found, is higher than it was when these were impressed, the limit of error being the number of feet which would represent the difference between the ebb and flow of the sea in the locality, or perhaps not more than fifty feet. We have thus a bench-mark to test the rise not only of these strata at Beauharnois, but of their equivalents, wherever else they may be met with.

Finding that this ancient sand bank was exposed at the ebb of tide we naturally look out for some coast to which it was related. The Potsdam sandstone terminates some twenty miles

1.



One-thirtieth natural size.

to the north at a very low angle against the foot of the Laurentide hills, which rapidly rise up 500 or 600 feet above the Silurian plain. There is little doubt that we have in the flank of those hills the ancient limit of the Lower Silurian sea, the shore of which is thus traceable from Labrador by the northwest, to the Arctic Ocean, a distance of 3,000 miles. But though we

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have thus evidence of a Lower Silurian dry land and can scarcely suppose that it was wholly destitute of vegetation, we have not yet discovered any certain drifted vestige of its plants along many hundred miles of its coast.

The crustacean which impressed the tracks at Beauharnois must have been a littoral animal, tracks of which have now been found in several places nearer than Beauharnois to the marginal limit of the sea to which it belonged. These localities are St. Ann, Vaudreuil, Presqu'ile, Lachute, and St. Elizabeth, and they were last year observed in the neighborhood of Perth. In the last locality they are associated with a new and remarkable description of track, for the discovery of which we are indebted to my friend Dr. James Wilson of Perth, who sent me specimens of it in the month of November last.

The largest of the specimens was between two and three feet long by a foot wide, and the track upon it so singular that I became desirous of obtaining a greater extent of the trail. For this purpose, in the beginning of December, I sent Mr. Richardson to Perth, where he was guided to the quarry by Dr. Wilson, and shewn the bed in which the tracks occur. The quarry, of which the strata are nearly horizontal, is about a mile from the town, and with the aid of Mr. Glyn, the proprietor, Mr. Richardson obtained in fragments, a surface which measures about seventy-six square feet. To obtain this required a good deal of patience, for there was half a foot of snow on the ground, and from under this it was necessary to remove between two and three feet of rock in order to reach the bed. The rock is a fine grained white sandstone similar to that in which the *Protichnites* occurs at Beauharnois, and of that pure silicious character which is so well known to belong to the Potsdam formation wherever it is met with. The tracks are impressed on a bed which varies in thickness in different parts from one eighth of an inch to three inches. When the upper bed was removed, large portions of the track-bearing bed came away with it, and it was necessary to separate the layers. This was done by heating the surface with burning wood placed upon it, and then suddenly cooling it by the application of snow. This of course cracked and destroyed the thin bed with the impressed

2.



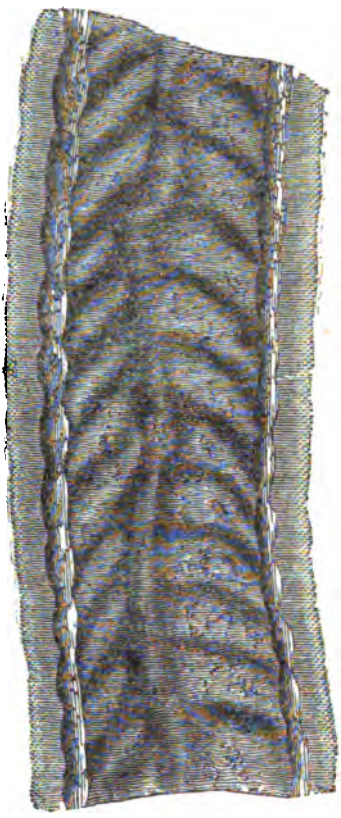
One-fifth nat. size.

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tracks, but it left the mould of them on the underside of the upper bed, and by plaster casts from this we have obtained the true form of the original tracks.

These tracks consist of a number of parallel ridges and furrows something like ripple marks, which are arranged between two narrow continuous parallel ridges, giving to the whole impression a form very like that of a ladder, and as the whole form is usually gently sinuous it looks like a ladder of rope. The surface obtained shews six different trails, (fig. 1,) the longest of which is about thirteen feet, but they are all of the same breadth, and they may all have been impressed by one and the same animal. The breadth of the trails is about six inches and three-quarters to the outer sides of them.

3.



One-fifth nat. size.

The transverse ridges and furrows are sometimes straight (fig. 2,) and sometimes curved (figs. 3, 4, 5.) When straight and regular they measure about an inch and three-quarters from the middle of one furrow to that of the next. The height of the ridge is usually from one and a half to two lines, and from the highest part of the distance to the middle of the furrows is about an inch and a quarter on one side and half an inch on the other, thus giving to the ridge a sharper slope on the shorter side. The tops of the ridges, and the bottoms of the furrows are somewhat rounded.

Though the transverse ridges are occasionally straight, (fig. 2,) they are in general either slightly or considerably curved (figs. 3, 4, 5,) and when so, the chord of the curve is seldom quite at right angles to the direction of the parallel side ridges, one end of the chord in the greatest obliquity observed being as much as two inches and a half in advance of the other (fig. 3). The height of the curve above the chord is sometimes as much as an inch and three

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quarters. It is often somewhat pointed, and the highest part is not always in the middle between the parallel side ridges (fig. 4). The concave side of the curve is always on the steeper side of the tranverse ridges.

There runs along the track a ridge intermediate between the two parallel side ridges, (figs. 3, 4, 5), and though it is not so conspicuous as these, it is seldom altogether wanting. but appears to be, most obscure when the transverse ridges, or rounds of the ladder, are straight. This intermediate ridge does not keep parallel with the side ridges, but occasionally runs in sinuous sweeps from within an inch and a half of one side (fig. 5) to the same distance from the other; sometimes, however, it runs nearly parallel with the sides for a considerable distance, either in the middle or somewhat on either side of it. In one of the tracks there is in the course of the intermediate ridge a sudden dislocation of an inch and a quarter (fig. 3 towards the top,) on the opposite sides of one of the transverse ridges. The course of the intermediate ridge appears in general to coincide with the successive most salient parts of the transverse ridges when these are curved, but this is not always the case (fig. 4). The intermediate ridge appears most conspicuous where it crosses the transverse furrows, yet its crest or line of summit seems to undulate with the ridges and furrows, though not to so great a degree.

4.



One-fifth nat. size.

5.



One-fifth nat. size.

The inner flanks of the side ridges appear to be continuously even surfaces, making an angle of 155° with the plane of the intermediate spaces, and against these sloping flanks the surface of the transverse undulations form a decided, though very obtuse set of angles, just like waves rolling along an inclined plane in the direction of its strike. The side ridges

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are rounded at the top, and while their exterior flanks are more precipitous than the interior ones, they swell out opposite to each transverse furrow, thus giving to the side ridges a beaded or knotted aspect, each bed of the series standing opposite a furrow. The highest part of these lumps is about three lines above the bottom of the furrows, and about a line and a half above the surface on which the track is impressed.

My naturalist friends to whom I have exhibited the specimens, appear disposed to consider the tracks those of some species of gigantic mollusc, and I am given to understand there is now living some small mollusc, whose track presents a series of transverse ridges and furrows, without, however, the longitudinal ones. From the resemblance of the track to a ladder, the name proposed for it is *Climactichnites Wilsoni*, the specific designation being given in compliment to its discoverer, Dr. Wilson.

Art. IV.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxix, p. 348, Second Series.)

No. 265. *Carex Emoryi*, Dew.

Spicis staminiferis ternis oblongis cylindraceis terminalibus, inferioribus brevioribus sessilibus approximatis et densifloris; pistilliferis quaternis longo-cylindraceis densifloris sessilibus foliaceo-bracteatis apice staminiferis, infima omnino fertili subremota; fructibus *distigmaticis* ellipticis basi teretibus brevi-rostratis ore integris squama ovata oblonga subacuta duplo longioribus.

Culm erect, scabrous above, triquetrous, with bracts long and leafy, surpassing, and scarcely sheathing it; the upper staminate spike clubform and short-pedunculate, the other two short, contiguous and sessile; the three upper pistillate spikes staminate at the apex, the lowest wholly fertile, nearly sessile and slightly sheathed; all cylindric, erect, about 1½ to 2 inches long and densely flowered; stigmas two; fruit narrow-elliptic, tapering below, flattish, obovate and apiculate or short-rostrate, with orifice entire, and scale ovate-oblong acutish and half the length of the fruit. Whole plant glaucous or pale green.

On the Upper Rio Grande; *Bigelow.* Named in honor of Major Wm. H. Emory, United States Commissioner on the United States and Mexican Boundary Survey.

This and all the species of this paper were described in the very important Botanical Report of Prof. Torrey, LL.D., in vol. ii, part i, pp. 229–232 of the Mexican Boundary Survey, published by Congress, 1859.

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No. 266. *C. Barbaræ*, Dew.

Spicis staminiferis 2 (raro 3) cylindraceis erectis terminalibusque, suprema longa pedunculata, infima subelongata; pistilliferis 3 longis 2–4 uncialibus cylindraceis, superiore erecta brevibracteata apice staminifera, inferioribus longioribus subremotis subrecurvis basi laxifloris brevi-vaginatis foliaceo-bracteatis, omnibus nigro-purpureis; fructibus *distigmaticis* oblongo-obovatis apiculatis ore integris squama oblongo-obovata dorso pallida *mucronata* brevioribus; culmo erecto glauco longo-foliato et vaginato.

Culm erect, 16–20 inches high, long-leafy towards the root and long-bracted above, glaucous; spikes 3–6, cylindric, slender, blackish purple; staminate spikes 1–3, upper nearly two inches long and pedunculate, the lower sessile and both contiguous and shorter, the lowest longer than the last and more remote; pistillate 3, long cylindric, 2–4 inches long, and slender, the upper staminate at the apex and erect; the lowest longer, subremote and subrecurved, short-sheathed and loose-flowered at the base; stigmas two; fruit oblong-obovate, short rostrate, entire at the orifice, with the scale oblong-obovate, pale on the back, with the nerve extended into a *mucronate* point and sometimes making the scale emarginate.

Banks of streams at Santa Barbara, California; *Dr. Parry*. The locality gives name to the species.

No. 267. *C. Thurberi*, Dew.

Spica staminifera solitaria sublonga, terminali squamis oblongis obtusis mucronatis; pistilliferis ternis oblongo-cylindraceis subcrassis vix nutantibus densifloris, infima exserto-pedunculata sublonge vaginata; fructibus *tristigmaticis* ovato-oblongis multi-nervosis brevi-conico-rostratis subventricosis bidentatis squama brevi oblonga obtusa dorso trinervata scabro-aristata longioribus vel basi spicarum brevioribus.

Culm two feet high, erect, scabrous above and smooth below the spikes, towards the root leafy, leafy-bracteate; a single, erect and long staminate spike; pistillate spikes three, cylindric, thickish, dense-flowered, pedunculate, the lowest sheathed and exsert; stigmas three; fruit oblong or ovate-oblong, tapering into a shortish beak, many-nerved, two-toothed and inflated; pistillate scale short-oblong, obtuse, scabrous-cuspidate, and shorter than the fruit except at base of the spikes. Related to C. hystricina, Willd., but remote.

At Mabibi, Sonora, in June; *Thurber*. It bears the honored name of its discoverer, one of the exploring party.

No. 268. *C. Wrightii*, Dew.

Spicis staminiferis 2 (raro 3) oblongo-cylindraceis erectis bracteatis subremotis cum squama oblonga acuta vel inferne aristata;

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pistilliferis 2–3 oblongo-cylindraceis, gracilibus remotis sublaxifloris exsertè pedunculatis, suprema apice stamenifera, infima longe vaginata exsertaque, omnibus foliaceo-bracteatis; fructibus *tristigmaticis* ovatis subconicis subtriquetris brevi-rostratis subscabris vix ventricosis bilabiatis squama ovato-oblonga cuspidata paulo longioribus vel basi paulo brevioribus.

Culm about a foot high, erect or subflaccid, leafy towards the root, and leafy bracteate; spikes 3–6, oblong cylindric; staminate 2, upper an inch long and pedunculate, the next one-third as long and near it usually, rarely a third which is remotish, and all bracteate; pistillate spikes, commonly 2–3, rarely one, rather remote and pedunculate, the upper staminate at the apex, the lowest longer pedunculate and exsert, all rather lax-flowered especially below; stigmas 3; fruit ovate, sub-conic, slightly triquetrous, short and round, short-rostrate, many nerved, bilabiate and subscabrous, a little longer than the ovate-oblong, rough-cuspidate scale, except at the very base of the spike: color of the plant, dark green.

In woods on the Colorado of Texas; *Wright.* It is honored by the name of its discoverer, another of the exploring party.

This species resembles C. scabrata Schw.; but it differs greatly in its staminate spikes, as well as in the pistillate and the fruit.

No. 269. *C. Schottii*, Dew.

Spicis staminiferis terminalibus 3–5 cylindraceis sæpe geminatis erectis approximatis nigro-rubris, superiori triunciali medio dilatata, reliquis brevioribus sessilibus contiguis vel infima remota et interdum geminata; pistilliferis 3 (raro 4) prolongo-cylindraceis gracillimis 6–8-uncialibus per-laxifloris inequaliter pedunculatis bracteatis, inferioribus longo-pedunculatis vix fructiferis vel abortivis cum squamis oblongis arctis obovatis vix acutis; fructu abortivo vel nimis immaturo *distigmatico;* culmis superne scabris, subprostratis? foliis bracteisque viridi-glaucis.

Culm near 20 inches high, triquetrous and scabrous above, subprostrate, with green glaucous leaves and bracts; spikes 6–8; sometimes staminate 5 and pistillate 3, or 4 and 3, 3 and 3, 3 and 4, most of which are long, and some very long, upper 3 staminate, near and almost geminate and quite variable, the highest 3 inches long and enlarged in the middle, with the dark red scale oblong and obovate, pale on the back; pistillate spikes 3, rarely 4, cylindric, very long, 4–8 inches and very slender, very lax-flowered and unequally pedunculate, the lowest long pedunculate and long vaginate, all leafy-bracteate and with scarcely the rudiment of fruit or else abortive; pistillate scale oblong, narrow-obovate, scarcely acute.

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Banks of rivers, Santa Barbara, California; *Dr. Parry.* This species has some affinity to C. Darwinii, Boott, Trans. Lin. Soc., vol. xx, p. 120, but differs much. The prostration of the culms may have been caused by some crushing force, without which the pistillate spikes must have been long-retrocurved, as in C. pendula, Goodenough. It bears the name of another distinguished member of the exploring party.

No. 270. *C. monticola*, Dew.

Spica staminifera solitaria inferne tereti erecta brevi-bracteata cum squamis oblongis obtusiusculis dorso excepto castaneis; pistilliferis binis sub-laxifloris, superiori sessili staminifera contigua, inferiore interdum subremota vaginata exserte pedunculata; fructibus di-tristigmaticis lato-ovatis oblongis convexo-concavis acutiusculis vix rostratis subvillosis nervosis ore integris vel subbifidis squama lato-ovata acuta longioribus vel inferiore mucronata paulo brevioribus; foliis vaginatis culmum superantibus.

Culm 8–10 inches high, scabrous above, leafy; leaves flat, rough on the edge, sheathed at the base and longer than the culm; one staminate ovate spike, with a sessile ovate pistillate spike near it and another pistillate spike subremote, often sheathed and exsertly pedunculate; stigmas *two and rarely three;* fruit ovate, flat, convex above, subacute scarcely rostrate, subvillose and nerved; lower scales of the fruit mucronate and a little longer than the fruit, while the others are acute and shorter than the fruit.

In the cases where the fruit is lenticular while the stigmas are sometimes three, probably one of the stigmas is barren or abortive.

Mountains east of San Diego, California; *Dr. Parry.* This is another of the few species having two stigmas with a single staminate spike.

Note 1.—*C. Umbellata*, Schk., Tab. w. w. w., fig. 171, and its var. *vicina* Dew., vol. x, [1], 31, and vol. xi, [1], 317, this Journ., have been found wide over the country.

The variety occurs also with *two* and *three* pistillate spikes, instead of one, near the staminate, besides the short and somewhat umbellate pistillate spikes near the root of the culm. Mexican Bound. Survey, vol. ii, Part I, p. 232.

Woods on the Colorado and Blanco rivers in Texas; *Wright.* Numerous specimens were brought by the discoverer, of the form given by Schkuhr, and of the variety mentioned; the latter being most common.

C. decidua, Boott, vol. xxvii, [2], p. 78, of this Journal, first found in Tierra del Fuego, afterwards in Sonora, California, by Dr. Parry, is presented fully in Boott, Illust. No. 157, Tab. 170. Dr. Boott shows its still wider range to the north in Oregon.

Note 2.—*C. phyllostachys*, p. 231, Mex. Bound. Surv., is a mistake for *C. Geyeri*, Boott.

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ART. V.—*The motions of Fluids and Solids relative to the Earth's Surface;* by W. FERREL, Assistant in the Nautical Almanac Office.

1. UNDER the above title I have published a paper in the Mathematical Monthly, in which I endeavored, by a complete analytical investigation of the motions of fluids surrounding the earth, arising from the different circumstances of a difference of pressure caused by a difference of temperature, combined with the modifying forces arising from the earth's rotation, to give a satisfactory explanation of all the general motions of the atmosphere and the ocean, the cause of the greater barometric pressure of the atmosphere near the tropics than at the equator and the poles, and of the greater pressure generally in the northern hemisphere than in the southern, to account for the motions of revolving storms in both hemispheres, from the equator towards the poles in the parabolic paths, and to establish completely their gyratory character; none of which phenomena had ever been satisfactorily accounted for by any of the theories which do not take into account the effect of the earth's rotation. It has been suggested by several that a paper more popular in its character, although less complete, which should contain only the more essential parts of the analysis, and in which familiar illustrations should supply in some measure the more difficult parts of the analysis, would be more satisfactory to many readers. It is proposed, therefore, in this paper, in consequence of the general interest taken in the subject, to treat it according to this suggestion, and to give only the most essential part of the analysis, showing the influence of the earth's rotation, which being based upon well known principles, instead of being deduced from general fundamental equations, is very simple, but is sufficient for a general understanding of the subject.

I. *The effect of the earth's rotation upon moving bodies at its surface.*

2. If a body were set in motion upon the surface of the earth, supposed to be entirely without friction, it would not in general move in the circumference of a great circle around the earth, but would be continually deflected to one side by a force arising from the earth's rotation.

Let r be the radius of the earth,
θ the polar distance in arc,
φ the longitude, and
n the angular velocity of the earth's rotation.

Then $r \sin \theta$ is the distance of a body on the earth's surface from the axis of rotation, and $r \sin \theta n^2$ the centrifugal force in

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the direction of a perpendicular to the earth's axis, arising from the earth's rotation. If in addition to the angular motion common to all bodies at rest on the surface of the earth, the body has an angular motion $D_t\varphi$ relative to the earth, then the centrifugal force becomes $r \sin\theta\,(n+D_t\varphi)^2$. Now if we resolve the preceding force in the directions of the meridian and a perpendicular to it, the part acting in the direction of the meridian, neglecting the small effect of the earth's ellipticity, is $r \sin\theta \cos\theta\,(n+D_t\varphi)^2$. The part of this force which gives ellipticity to the earth's surface, and which is necessary to keep a body at rest on the elliptical surface, and prevent it from sliding toward the pole, is $r \sin\theta \cos\theta\, n^2$. Hence the difference of these two forces, when the body has a motion eastward relative to the earth, is a deflecting force which has a tendency to cause the body to move from the pole toward the equator. The difference of these forces is $r \sin\theta \cos\theta\,(2n+D_t\varphi)\,D_t\varphi$, and hence when the body is entirely free to move in any direction, we have

$$(1.) \qquad r D_t^2\theta = r \sin\theta \cos\varphi\,(2n + D_t\varphi)\,D_t\varphi.$$

3. Again, if the body has a motion toward or from the pole, it must satisfy the well known principle of the preservation of areas, so that as it approaches the pole, and consequently the axis of rotation, the angular motion must be increased, that is, it must acquire a motion eastward relative to the earth, but if it recedes from the pole, it must acquire a relative westward motion. In order to satisfy the preceding principle, the motion must satisfy the following equation:

$$(2.) \qquad r^2 \sin^2\theta\,(n + D_t\varphi) = \text{constant}.$$

Taking the derivative with regard to t we get

$$(3.) \qquad r \sin\theta\, D_t^2\varphi = -2r \cos.\theta\,(n + D_t\varphi)\,D_t\theta.$$

4. Equations (1) and (3) determine the motions of a free body on the earth's surface. If the body is constrained to move either in the direction of a meridian or a parallel of latitude only, the deflecting force instead of causing a deflection, causes only a pressure. If we put P for the part of the force or pressure acting in the direction of the meridian, which depends upon the earth's rotation only, and Q for the part depending upon the earth's rotation, which acts in the direction of a parallel of latitude, we have

$$(4.) \qquad \begin{cases} P = 2rn \sin\theta \cos\theta\, D_t\varphi \\ Q = -2rn \cos\theta\, D_t\varphi. \end{cases}$$

In the preceding equations $rD_t\theta$ represents the lineal velocity of the body in the direction of the meridian, and $r \sin\varphi D_t\varphi$ the lineal velocity relative to the earth in the direction of the parallel of latitude. Hence the deflecting force is the same in both directions in the same lineal velocity.

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5. If v is the velocity of a body moving in any direction whatever, and F the deflecting force perpendicular to this direction, by resolving the preceding forces and velocities in the direction of v and the perpendicular to it on the right, we get

$$F = 2nv\cos\theta. \tag{5.}$$

In the northern hemisphere $\cos\theta$ is positive, but in the southern negative. Hence, we have established this important principle, *in whatever direction a body moves, it is always deflected to the right in the northern hemisphere, and the contrary in the southern hemisphere.*

The forces resolved in the direction of v cancel each other, and hence the velocity is never accelerated or retarded.

6. Since rn^2 represents the centrifugal force at the equator arising from the earth's rotation, and is known to be $\frac{1}{289}$ of g or gravity, the preceding equation may be reduced to

$$F = \frac{2v\cos\theta}{289n}g. \tag{6.}$$

This form of the equation is convenient for comparing the force F with gravity.

7. In the preceding equations rn is the lineal velocity of the equator, and is equal to 1523·2 feet, the second being the unit of time. Hence $n = 000072924$. Also $g = 32{\cdot}2$ feet.

It may be remarked here that the preceding deflecting force is not an absolute force, such as would be required to deflect a moving body from a fixed direction in space, but is only relative, being somewhat of the nature of a centrifugal force, and arises from the fact that the direction relative to the earth to which the moving body is referred, is continually changing its direction with regard to fixed directions in space.

II. *The general Motions and Pressure of the Atmosphere.*

8. By the general motions of the atmosphere are meant all those motions produced by a difference of density between the equatorial and polar regions arising principally from a difference of temperature. If the atmosphere in all parts of the earth had the same density, every part would be in a state of statical equilibrium, and its surface and the strata of equal density would assume the elliptical figure of the earth's surface, and consequently the pressure of the atmosphere at the earth's surface would be everywhere the same. But the temperature of the atmosphere being less and consequently its density greater in the polar than the equatorial regions, the greater pressure of the polar regions causes the surface of the atmosphere and the strata of equal density in the equatorial regions to rise a little above the level of equilibrium, and hence the atmosphere in the upper regions flows toward the poles, while the greater pressure of the

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polar regions causes a counter current toward the equator in the parts nearer the earth's surface, which would extend down to the earth's surface, if it were not for the modifying causes arising from the friction of the earth's surface, which will be explained. If the earth had no rotation on its axis, this interchanging motion between the equatorial and polar regions would be exactly in the directions of the meridians; but having a rotation, from what has been demonstrated in the preceding section, the atmosphere above in flowing toward the poles acquires an eastward motion relative to the earth's surface, and after descending in the polar regions and flowing back nearer the earth's surface toward the equator, it tends toward the west, and on arriving in the equatorial regions it has a westward motion. If it were not for the resistance of the earth's surface, the mutual actions of the strata upon one another, whatever the initial state of the atmosphere, would cause them to have finally the same east or west motion at all heights in the same latitude, and this motion would be such as to satisfy equation (2), and also, since the mutual actions of the strata upon one another could not affect the sum of the moments, it would be such that the sum of the moments of all the particles would be the same as that of the initial state arising from the earth's rotation and from any initial motion relative to the earth, which it might have had. This latter condition determines the constant in equation (2), which was shown in my paper in the Mathematical Monthly, to which I must refer for the method, to be, on the hypothesis of an initial state of rest relative to the earth, equal to $\frac{2}{3} r^2 n$. With this value of the constant the equation gives

$$(7.) \qquad D_t\varphi = \left(\frac{2}{3\sin^2\theta} - 1\right) n.$$

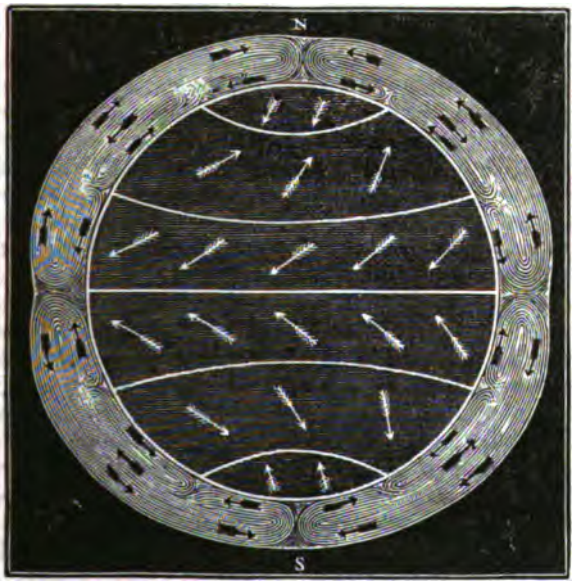
9. Near the poles, where $\sin^2\theta$ is very small, $D_t\varphi$ and consequently the lineal velocity $r\sin\theta D_t\varphi$ must be very great. Toward the equator $D_t\varphi$ is negative, and hence the motion there is westward. Putting $D_t\varphi = 0$, the equation gives $\sin^2\theta = \frac{2}{3}$, and hence the sine of the latitude where there is no motion east or west is equal to $\sqrt{\frac{1}{3}}$, which answers nearly to the parallel of 35°. Hence between this parallel and the poles the motion is eastward, but between it and the equator, toward the west. From what has been shown therefore in § 2, the eastward motion toward the poles, and the westward toward the equator, since $D_t\varphi$ is negative there, must both cause a pressure toward the parallels of 35°, and consequently an accumulation of atmosphere there, and a depression at the poles and at the equator. The amount of the pressure is represented by the term $r\sin\theta\cos\theta(2n + D_t\theta) D_t\varphi$, and hence toward the pole, where $D_t\varphi$ is very large, this pressure is very great, and at the poles it would

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be infinite. Hence at the poles and at some distance from them, on the hypothesis of no resistances from the earth's surface, the atmosphere cannot exist. Between the parallels of 35° and the equator $D_t\varphi$ is less and also $\cos\theta$, and consequently the pressure from the equator and the depression there are comparatively small. It was shown in the Mathematical Monthly that in the case of a fluid surrounding the earth five miles high, the fluid would recede from the poles about 28° and be depressed at the equator about 4000 feet. This, however, is upon the hypothesis that the upward expansion of the atmosphere arising from a greater temperature is insensible.

10. The preceding results, it must be remembered, are all upon the hypothesis that the atmosphere is not resisted in its motions by the friction of the earth's surface. Although these results are much modified by the resistance of the earth's surface, yet they will be of great advantage in explaining its general motions; for as there can be no resistance until there is motion, the atmosphere must have a tendency to assume, in some measure, the same motions and figure as in the case of no resistances. Hence, towards the poles the general motions of the atmosphere must be towards the east, and in the torrid zone towards the west;

1.



but as these motions, in consequence of the resistances, are small in comparison with those in the case of no resistances, instead of the atmosphere's receding entirely from the poles, there must be

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only a comparatively small depression there, as represented in the figure, and instead of its being about 4,000 feet lower at the equator than at the place of its maximum height near the tropics, there must be only a very slight depression there, both on account of the small pressure from the equator, and also on account of the upward expansion arising from a greater temperature.

11. That the atmosphere must assume the preceding figure in consequence of the eastward motion toward the poles and westward motion near the equator, will be readily understood from the following illustration. It is well known that if the atmosphere had the same motion of rotation with the earth, that it would assume the same figure. Now, if the whole atmosphere had a greater angular motion, that is, if it had an eastward motion relative to the earth, the increased centrifugal force would evidently cause it to accumulate at the equator and to be depressed at the poles. On the other hand, if it had a less angular motion, that is, a motion westward relative to the earth, it would accumulate at the poles and be depressed at the equator. Hence, since the motion is eastward in the higher latitudes and westward near the equator, it is plain that there must be a depression at both the poles and the equator, and consequently an accumulation having its maximum height at some parallel between.

12. The force which overcomes the resistance of the earth's surface to the east and the west motions of the atmosphere depends upon the term in equation (3) containing $D_t \theta$ as a factor, which depends upon the interchanging motion of the fluid between the equatorial and the polar regions, and hence the term must vanish at the equator and the poles. All the east or west motion of the atmosphere is consequently destroyed by the resistances at these places, and hence as $D_t \theta$ vanishes there also, there is a belt of calms at the equator, called the equatorial calm belt, and there must be also a region of calms about the poles.

13. As the motion of the atmosphere is east towards the poles and west near the equator, somewhere between the equator and the poles there must be a parallel of no motion east or west, which, in the case of no resistance, was determined upon the hypothesis of an initial state of rest, and found to be at the parallel of 35°, (§ 9). In the case of the atmosphere this parallel is entirely independent of the initial state of the atmosphere, and depends in a great measure upon the law of resistance, and hence it cannot be accurately determined. It is evident, however, that the east and west motions of the atmosphere at the earth's surface must be such that the sum of the resistances of each part of the earth's surface multiplied into its distance from the axis of rotation, must be equal to 0, else the velocity of the earth's rotation would

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be continually accelerated or retarded, which cannot arise from any mutual action between the surface of the earth and the surrounding atmosphere. Now, as the part of the earth's surface where the motion of the atmosphere is west is much farther from the axis than the part where it is east, the latter part must comprise more than half of the earth's surface, unless the velocity of the eastern motion towards the poles is much greater than that of the western motion near the equator. Therefore, since one-half of the earth's surface is contained between the parallels of 30°, the parallels of no east or west motion at the earth's surface must fall within these parallels, and they are accordingly found on the ocean to be near the tropics. Hence the maximum height of the atmosphere, as represented in the figure, must also be near the same parallels.

14. The increase of pressure arising from the accumulation of atmosphere near the tropics, caused principally by the deflecting forces (§ 5) arising from the more rapid east and west motions of the atmosphere in the upper regions, where there is least resistance, gives the atmosphere a tendency to flow from beneath this accumulation both towards the equator and the poles, since the motions, and consequently the forces, which cause this accumulation, are much less near the surface. But on account of the greater density of the atmosphere towards the poles, it has a tendency also to flow, at the earth's surface, from the poles towards the equator. Between the parallels of greatest pressure and the equator, these tendencies combine, and produce a strong surface current, which, combining with the westward motion there, gives rise to the well-known northeast wind in the northern hemisphere, and the southeast wind in the southern hemisphere, called the trade winds. But between the parallels of greatest pressure and the poles, these tendencies are opposed to each other, and the one arising from the accumulation of atmosphere near the tropics being the greater in the middle latitudes, causes the atmosphere to flow at the earth's surface towards the poles; and this motion, combining with the general eastward motion of the atmosphere in those latitudes, gives rise to the southwest wind in the northern hemisphere and the northwest wind in the southern hemisphere, called the passage winds.

15. Near the poles, the tendency to flow towards the equator seems to be the greater, and causes a current there *from* the poles, which, being deflected westward (§ 5,) causes a slight northeast wind in the north frigid zone, and a southeast wind in the south frigid zone. But this is only near the earth's surface; and the general tendency of the atmosphere in the upper regions must be towards the east, as will be seen.

16. Since the atmosphere near the tropics can have no motion in any direction at the earth's surface, there are calm belts there,

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called the tropical calm belts. Near the polar circles, where the polar and passage winds meet, there must also be calm belts, which may be called polar calm belts. The motions of the atmosphere, therefore, at the earth's surface, if they were not modified by the influence of continents, would be as represented in the interior of the figure, in which the heavy lines represent the calm belts. On account of the influence of the continents, these belts are somewhat displaced and irregular, and on account of the varying position of the Sun, they change their positions a little in different seasons of the year.

The southern limit of the polar winds in the northern hemisphere, and also the limit between the trade and passage winds, has been determined by Prof. J. H. Coffin, from the discussion of a great number of observations at different points, and given in a chart, in his treatise on the winds, published in the seventh volume of the Smithsonian Contributions.

17. That the atmosphere is depressed at the equator and the poles, and has its maximum height near the tropics, as has been represented, is indicated by barometrical pressure. It was formerly thought that this pressure, at the level of the ocean, was very nearly 30 inches in all latitudes; but it is now well established that it is much less towards the poles than near the tropics, and also a little less at the equator. Says Captain Wilkes: "The most remarkable phenomenon which our observations have shown is the irregular outline of the atmosphere surrounding the earth as indicated by the pressure upon the measured column at different parts of the surface. Our barometrical observations show a depression within the tropics, a bulging in the temperate zone, again undergoing a depression on advancing towards the arctic and antarctic circles."

Says Sir James Ross:* "Our barometrical experiments appear to prove that the atmospheric pressure is considerably less at the equator than near the tropics; and to the south of the tropic of Capricorn, where it is greatest, a gradual diminution occurs as the latitude is increased, as will be shown from the following Table, derived from hourly observations of the height of the column of mercury between the 20th of November, 1839, and the 31st of July, 1843."

Extract from Ross's Table.

Latitude.	Pressure.	Latitude.	Pressure.	Latitude.	Pressure.
	inches.		inches.		inches.
Equator,	29·974	42° 53′	29·950	55° 52′	29·360
13° 0′ S.	30·016	45 0	29·664	60 0	29·114
22 17	30·085	49 8	29·467	66 0	29·078
34 48	30·028	51 33	29·497	74 0	28·928
		54 26	29·347		

* Voyage to the Southern Seas, vol. ii, p. 383.

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18. The following table, first published by M. Schouw, and reduced here from millimetres to English inches, shows that there is a similar bulging of the atmosphere in the middle latitudes and depression at the pole in the northern hemisphere, as has been observed in the southern hemisphere.

Place.	Latitude.	Pressure.	Place.	Latitude.	Pressure.
		inches.			inches.
Cape,	33° 0′ S.	30·040	London,	51° 30′	29·961
Rio Janeiro,	23 S.	30·073	Altona,	53 30	29·937
Christianburg,	5 30 N.	29·925	Dantzic,	54 30	29·925
La Guayra,	10	29·928	Konigsberg,	54 30	29·941
St. Thomas,	19	29·941	Apenrade,	55	29·905
Macao,	23	30·039	Edinburgh,	56	29·851
Teneriffe,	28	30·087	Christiana,	60	29·866
Madeira,	32 30	30·126	Bergen,	60	29·703
Tripoli,	33	30·213	Hardanger,	60	29·700
Palermo,	38	30·036	Reikiavig,	64	29·607
Naples,	41	30·012	Godthaab,	64	29·603
Florence,	43 30	29·996	Eyaflord,	66	29·669
Avignon,	44	30·000	Godhaven,	69	29·674
Bologna,	44 30	30·008	Upernavik,	73	29·732
Padua,	45	88·008	Mellville Isle,	74 30	29·807
Paris,	49	29·976	Spitzbergen,	75 30	29·795

19. From the preceding tables, it is seen that the barometric pressure is much less, especially in the southern hemisphere, towards the poles than at the equator, although the density towards the poles is much greater, and hence the depression there must be considerable.

20. It has been seen (§ 1), that, in consequence of the earth's rotation, the interchanging motion of the atmosphere between the equator and the poles give rise to a force, by which this motion itself is counteracted. For instance, the motion toward the poles in the upper regions causes an eastward motion which gives rise to a force toward the equator, and which, consequently, counteracts the motion toward the poles, and the motion toward the equator produces a westward motion which gives rise to a force acting in the direction of the poles, which counteracts the motion toward the equator. The motion of the atmosphere, therefore, between the equator and the poles, is not produced by the whole force arising from the difference of density between the equator and the poles, but by a small difference only between the two forces. Hence if the earth had no rotatory motion, the force which produces this motion would be very much greater, and there would be a sweeping hurricane from the pole to the equator.

21. It is evident, where the motions of the atmosphere are resisted by the earth's surface, that all the conditions cannot be satisfied by a motion at the surface from the poles towards the equator, and by a counter motion in the upper regions. For we have seen (§ 13,) that the atmosphere at the surface of the earth

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must have an eastern motion in the middle latitudes; but it cannot have such a motion, unless it also have a motion toward the poles, in order that the deflecting force (§ 5) arising from this motion may overcome the resistance to the eastern motion. But it is evident there cannot be a complete reversal of the motions in the middle latitudes, but some portion of it must flow toward the poles in the upper regions, else the eastern motion there could not be greater than at the surface, which the conditions require. The motions, therefore, must be somewhat as represented in the figure. The part of the atmosphere next the earth's surface in the middle latitudes having a motion towards the poles, extends to a considerable height, since it generally embraces the region of fair weather clouds, as may be seen by observation.

22. Since the force arising from the eastward motion of the atmosphere above must resist in a great measure the tendency to flow from the equator to the poles, caused by the difference of level arising from a greater upward expansion of the atmosphere near the equator on account of a greater temperature, and since this difference of level, and consequently the tendency to flow toward the poles, must increase with the height, the eastward motion in the middle and higher latitudes must be much greater above than below, and in the trade wind region, near the tropical calm-belts, where the motion is westward below it must be toward the east above. This is also evident from the general consideration, that the whole amount of deflecting force eastward arising from the motion of the atmosphere towards the poles is equal to the deflecting force westward arising from its motion back towards the equator, and that the deflecting force eastward is principally above where there is less resistance than near the surface. Hence, at the top of Mauna Loa in the Sandwich Islands, and on the peak of Teneriffe, both of which places are near the tropical calm-belt at the surface, a strong southwest wind prevails. Hence, also, "on the eruption of St. Vincent, in 1812, ashes were deposited at Barbadoes, sixty or seventy miles eastward, and also on the decks of vessels one hundred miles still further east, whilst the trade wind at the surface was blowing in its usual direction." The eastward motion of the atmosphere above, in the latitudes of the trade winds, is also confirmed by observations made on the directions of the clouds at Colonia Tovar, Venezuela, latitude 10° 26′, as given in the Report of the Smithsonian Institution for 1857 (p. 254). While the motion of the lower clouds was in general from some point towards the east, the observed motion of nearly all the higher clouds was from some point towards the west.

23. From what precedes, the limit between the atmosphere which moves eastward in the middle latitudes and westward nearer the equator, which at the earth's surface is at the tropical

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calm belt, must be a plane inclining toward the equator above. And since, according to (§ 21), the atmosphere near the earth's surface cannot have an eastward motion, unless it also has a motion toward the poles, this plane near the earth's surface must nearly coincide with the one which separates the atmosphere moving towards the poles from that moving towards the equator, in the trade wind regions, and hence the latter must also incline above towards the equator. This explains the winds at the peak of Teneriffe, which at the top always blow from the southwest while at the base they blow alternately from the northwest and northeast, changing with the seasons. As the tropical calm belt together with this dividing plane changes its position with the seasons, as will be explained, in the latter part of summer when this plane is farthest north, it still leaves the top of the peak north of it while the base is south of it; and hence the wind at the top always blows from the southwest, even when at the base it blows from the northeast. As this plane moves south in the fall, more of the peak gradually becomes north of it; and hence the southwest wind, which always prevails at the top, gradually descends lower on the sides of the peak until it reaches the base. Hence, when this plane reaches its most southern position, in the latter part of winter, the southwest wind prevails at both the base and the top.

24. The depression of the atmosphere at the poles and at the equator, and the accumulation near the tropics, may be explained in a general manner by means of the principle in (§ 5) that when a body moves in any direction in the northern hemisphere, it is deflected to the right, and the contrary in the southern. The atmosphere towards the poles having an eastward motion, the deflecting force arising from it causes a pressure towards the equator, and the motion near the equator being westward, the pressure is towards the poles; and hence there must be a depression at the poles and at the equator, and an accumulation near the tropics. Since this deflecting force is as $\cos\theta$, it is small near the equator; and, consequently the depression there is small.

25. According to the preceding tables of barometric pressure, there is more atmosphere in the northern than in the southern hemisphere. Says Sir James Ross, "the cause of the atmosphere being so very much less in the southern than in the northern hemisphere remains to be determined." This is very satisfactorily accounted for by the preceding principle; for as there is much more land, with high mountain ranges, in the northern hemisphere, than in the southern, the resistances are greater, and consequently the eastern motions, upon which the deflecting force depends, is much less; and the consequence is, that the more rapid motions of the southern hemisphere cause a greater

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depression there, and a greater part of the atmosphere to be thrown into the northern hemisphere.

This also accounts for the mean position of the equatorial calm belt being, in general, a little north of the equator. But in the Pacific Ocean, where there is nearly as much water north of the equator as south, its position nearly coincides with the equator.

For the same reason the tropical calm belt of the northern hemisphere is farther from the equator than that of the southern hemisphere; and, on account of the irregular distribution of the land and water of the two hemispheres in different longitudes, it does not coincide with any parallel of latitude. In the longitude of Asia, where there is all land in the northern hemisphere and the Indian Ocean in the southern, this belt, which is also the dividing line which separates the winds which blow east from those which blow west, is farther from the equator than at any other place, as shown by Professor Coffin's chart.

26. In winter, the difference of temperature between the equator and the poles, upon which the disturbance of the atmosphere depends, is much greater than in summer; this causes the eastward motion of the atmosphere in either hemisphere during its winter to be greater, while in the other hemisphere it is less. Hence a portion of the volume of the atmosphere in winter is thrown into the other hemisphere; but, although the volume or height of the atmosphere is then less, yet, being more dense, the barometric pressure remains nearly the same. The difference at Paris, and in the middle latitudes generally, between winter and summer, is only about $\frac{1}{10}$ of an inch.

On account of this alternate change with the seasons of the velocity of the eastward motion of the atmosphere in the two hemispheres, the equatorial and tropical calm belts change their positions a little, moving north during our spring, and south in the fall.

III. *The Motions of the Atmosphere arising from local disturbances.*

27. Besides the general disturbance of equilibrium arising from a difference of specific gravity between the equator and the poles, which causes the general motions of the atmosphere, treated in the last section, there are also more local disturbances, arising from a greater rarefaction of the atmosphere over limited portions of the earth's surface, which give rise to the various irregularities in its motions, including cyclones or revolving storms, tornadoes, and water-spouts. When, on account of greater heat, or a greater amount of aqueous vapor, the atmosphere at any place becomes more rare than the surrounding portions, it ascends, and the surrounding heavier atmosphere flows in below, to supply its place, while a counter current is consequently pro-

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duced above. As the lower strata of atmosphere generally contain a certain quantity of aqueous vapor, which is condensed after arising to a certain height, and forms clouds and rain, the caloric given out in the condensation, in accordance with Espy's theory, produces a still greater rarefaction, and doubtless adds very much to the disturbance of equilibrium, and to the motive power of storms. So long, then, as the ascending atmosphere over the area of greater rarefaction is supplied with aqueous vapor by the current flowing in from all sides below, the disturbance of equilibrium must continue, and consequently the local disturbances of the atmosphere to which it gives rise, whether those of an ordinary rain storm, or a cyclone, may continue many days, while the general motions of the atmosphere may carry this disturbed area several thousands of miles.

28. When the area of rarefaction is such as to cause the atmosphere to flow in below from all sides toward a centre and the reverse above, thus establishing a constantly interchanging motion between the internal and external part, the case becomes very similar to that of the general hemispherical motions of the atmosphere in which the motion is between the polar and equatorial parts. For if the earth's rotation on its axis is analyzed with reference to any other axis, the pole of which is at the distance of θ from the pole of the earth, it is found to have a rotation around this latter axis equal to $n \cos \theta$ (Peirce's *Analytical Mechanics*, § 25). Hence the interchanging motion between the internal and external part in this case must cause the internal part to gyrate around the centre from right to left in the northern hemisphere, and the external part the contrary way, and thus give rise to a cyclone or revolving storm just as in the case of the hemispherical motions the part nearest the pole acquires an eastward motion, and that near the equator a westward motion. This is also evident from the principle demonstrated in § 5, according to which the atmosphere in flowing toward the center below, must be always deflected in the northern hemisphere to the right, and consequently give it a gyratory motion around the center from right to left. In moving out above toward the external part, the deflection tends to give the atmosphere a gyratory motion the contrary way, and hence in flowing out above the gyratory motion which it has while rising to the upper strata in the interior, is not only destroyed but on arriving at the external part it has a gyratory motion the contrary way. In the southern hemisphere, since the deflections there are all to the left of the direction of motion, the gyrations are all reversed, which is the observed law of storms in all parts of the world, as shown by Redfield, and also by Reid, in his *Law of Storms*. It is also evident that at the equator, where $\cos \theta$ vanishes, upon which the deflecting force depends, there cannot be a cyclone, and hence,

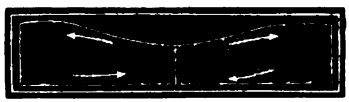
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of all those which Redfield has investigated, and given in his charts of their routes, none have been traced within 10° of the equator. The typhoons or cyclones, also, of the China sea, have never been observed within 9° of the equator.

29. In the case of the general hemispherical motions the internal or polar part is most dense, but in the case of cyclones the external part. Hence the motions between the centre and the external part are different, in the former case the motion toward the centre being above, but in the latter below. In the case of no resistances from the earth's surface this does not affect the gyrations, since on account of the action of the different strata upon one another, they all eventually have the same gyratory motion. But where there are resistances, they cause the gyrations in the external part to be most rapid above just as in the system of hemispherical motions, they are most rapid above in the internal or polar part.

30. If the gyrations were not resisted by the earth's surface it is evident that the rapid gyrations of the cyclone would cause the atmosphere to recede entirely from the centre, but on account of the resistance the very rapid gyrations are in general in a great measure prevented, so that instead of a complete vacuum the strata of the atmosphere are only somewhat depressed in the interior, as represented in fig. 2. For since the force which produces the gyrations depends upon the velocity of the flow to and from the centre, it is evident, that, at the centre and at the external part of the disturbed portion of atmosphere, where this velocity must vanish, the resistances destroy all gyratory motion. Hence, instead of very rapid gyrations near the centre, as in the case of no resistances, there must be a calm there, and the most rapid gyrations be at some distance from the centre, in accordance with observation. The diameter of the comparatively calm portion, in the centre of the large cyclones, is sometimes about 30 miles. The velocity of gyration of the external part, which, in the case of no resistances, is small, is in a great measure destroyed by the resistances of the surrounding atmosphere, so that it is, for the most part, insensible to observation, and only the more rapid gyrations of the internal part are observed. The motion of gyration combined with the motion at the earth's surface towards the centre, gives rise to a spiral motion towards the centre, exactly in accordance with the observed motions of the atmosphere in great storms or hurricanes, as has been shown by Redfield, in a number of papers on the subject, published in this Journal.

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31. Since the atmosphere is depressed in the middle of cyclones, they must sensibly affect the barometer; and this is the true cause of all the great barometrical oscillations, as was first suggested by Redfield.* As the cyclone approaches, there is generally a very slight rise of the barometrical column, which is at its maximum at the greatest accumulation near the external part of the cyclone, after which it is gradually depressed, until the middle of the cyclone arrives, where the atmosphere is most depressed, when the barometer is at its minimum, and then it returns in a reverse manner to its former height, when the cyclone has passed. In great storms the mercury sometimes falls more than two inches. In oblong storms, and all imperfectly developed cyclones, the same phenomena must take place in some measure, as in a complete cyclone. We have reason to conclude, therefore, that nearly all the oscillations of the barometer are caused by a cyclonic motion of the atmosphere, by which it is depressed in the middle of the cyclones. The cyclones may be very irregular and imperfectly developed, and not of sufficient violence to produce a strong wind, and several may frequently interfere with one another, so that the oscillations may frequently be very slight ones only, and very irregular.

Since the gyratory motion of a cyclone, and the consequent depression at the centre, depend upon a term containing as a factor, $\cos \theta$, (§ 28), which is the sine of the latitude, according to the preceding theory of barometrical oscillation, the oscillations should be small near the equator, and increase towards the poles, somewhat as the sine of the latitude. Accordingly, at the equator, the mean monthly range of oscillation is only two millimetres, or less than $\frac{1}{10}$ of an inch, while there is a gradual increase with the latitude; so that at Paris it is $23{\cdot}66^{mm}$, and at Iceland, $35{\cdot}91^{mm}$. (Kaemtz's *Meteorology*, by C. Walker, page 297.)

32. The greater rarefaction of the atmosphere at some times than at others, without doubt, has considerable effect upon the barometer; but the theory which attributes the whole of the barometrical oscillations to the rarefaction of the atmosphere produced by the condensation of vapor in the formation of clouds and rain, can not be maintained; for according to that theory, in the rainy belt near the equator, where there are always copious rains during the day, which are succeeded by a clear atmosphere during the night, the oscillations of the barometer should be greatest, and towards the poles, where there is little condensation of vapor into rain, they should be the least; but we have seen that just the reverse of this is true. The atmosphere is extremely mobile, so that if there were much difference

* This Journal, [1], xx, 45.

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of pressure between one part and the surrounding parts, the equilibrium would be at once restored if the motions toward the centre produced by this difference of pressure, did not give rise to a cyclonic motion, and thus to a centrifugal force combined with the deflecting force arising from the earth's rotation which in a great measure counteracts the force arising from a difference of pressure between the external and internal parts. If therefore the earth had no rotation, the oscillations of the barometer would be no greater in any part of the earth than they are at the equator.

33. When the disturbance of equilibrium is great, but extends over a small area only, the centripetal force is much greater than in the case of large cyclones, and the gyrations are then very rapid and very near the centre, as in the case of tornadoes. Tornadoes generally occur when the surface of the earth is very warm, and the atmosphere calm. For then the strata near the surface becomes very much rarefied, and are consequently in a kind of unstable equilibrium for a while, when from some slight cause, the rarefied atmosphere rushes up at some point through the strata above, and consequently flows in rapidly from all sides below, and then, unless the sum of all the initial moments of gyration around the centre is exactly equal 0, which can rarely ever be the case, it must run into rapid gyrations near the centre, and a tornado is the consequence. This may be exemplified by the flowing of water through a hole in the bottom of a vessel. If the fluid at the beginning is entirely at rest, it runs out without any gyrations; but if there is the least perceptible initial gyratory motion, it runs into very rapid gyrations near the centre.

34. In the case of tornadoes, which are always of small extent, the influence of the earth's rotation in producing gyrations is generally very small in comparison with that of the initial state of the atmosphere, so that the gyration depends principally upon the initial gyratory state of the atmosphere with regard to the centre of the tornado, and may be either from right to left, or the contrary. Hence there may be tornadoes at the equator, although there cannot be large cyclones. In large cyclones the effect of the initial state, except at the equator, is insignificant in comparison with the influence of the earth's rotation; and the latter, moreover, is a constant influence, while the former is soon destroyed by resistances. Hence large cyclones are of long duration, while small tornadoes, depending principally upon the initial gyratory state for their violence, are soon overcome by the resistances.

35. On account of the centrifugal force arising from the rapid gyrations near the centre of a tornado, it must frequently be nearly a vacuum. Hence, when a tornado passes over a build-

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ing, the external pressure, in a great measure, is suddenly removed, when the atmosphere within, not being able to escape at once, exerts a pressure upon the interior of perhaps nearly fifteen pounds to the square inch, which causes the parts to be thrown in every direction to a great distance. For the same reason, also, the corks fly from empty bottles, and every thing with air confined within, explodes.

36. When a tornado happens at sea, it generally produces a water-spout. This is generally first formed above, in the form of a cloud, shaped like a funnel or inverted cone. As there is less resistance to the motions in the upper strata than near the earth's surface, the rapid gyratory motion commences there first, when the upper strata of the agitated portion of atmosphere have a tendency to assume somewhat the form of the strata in the case of no resistance. This draws down the strata of cold air above, which, coming in contact with the warm and moist atmosphere ascending in the middle of the tornado, condenses the vapor and forms the funnel-shaped cloud. As the gyratory motion becomes more violent, it gradually overcomes the resistances nearer the surface of the sea, and the vertex of the funnel-shaped cloud gradually descends lower, and the imperfect vacuum of the centre of the tornado reaches the sea, up which the water has a tendency to ascend to a certain height, and thence the rapidly ascending spiral motion of the atmosphere carries the spray upward, until it joins the cloud above, when the water spout is complete. The upper part of a water-spout is frequently formed in tornadoes on land.

When tornadoes happen on sandy plains, instead of water-spouts they produce the moving pillars of sand which are often seen on sandy deserts.

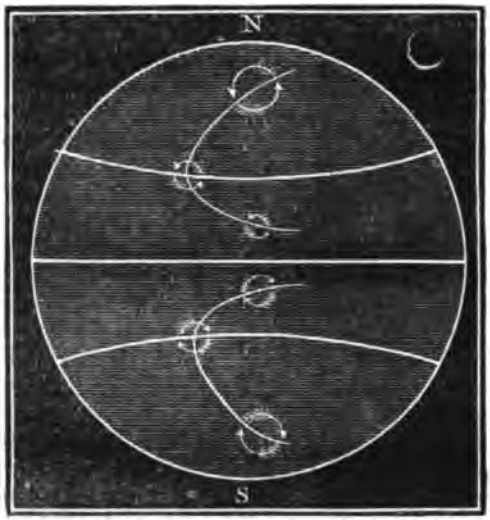
37. The routes of cyclones in all parts of the world, which have been traced throughout their whole extent, have been found by Redfield* to be somewhat of the form of a parabola, as represented in fig. 3. Commencing generally near the equator, the cyclone at first moves in a direction only a little north or south of west, according to the hemisphere, when its route is gradually recurvated towards the east, having its vertex in the latitude of the tropical calm belt. The motion of a cyclone toward the poles may be accounted for by the principle in § 5. The motion of the equatorial side of a cyclone in either hemisphere is always toward the east, and hence the deflecting force causes a pressure toward the equator, but that of the polar side being always toward the west, the deflecting force causes a pressure toward the pole. Now these deflecting forces being as the sine of the latitude, as may be seen from (§ 5), the pressure on the polar side toward

* See this Journal, Second Series, vol. i, Chart i.

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the pole is greater than on the other side toward the equator, and hence the cyclone moves in the direction of the greatest pressure. It is not to be supposed, however, that there is an actual transfer of all the atmosphere of a cyclone from the equator to the polar regions. For the motions and pressure of the cyclone being greater on the polar side, where the deflecting forces which cause it are greatest, its action upon the atmosphere in advance of it is greater than on the equatorial side, where these forces are much

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less, and hence new portions of the atmosphere are being continually brought into action on the one side, while the resistance of the earth's surface, and the adjacent portions of atmosphere on the other side, are continually overcoming the comparatively weak forces there, and destroying the gyratory motion of the cyclone; so that the centre of the cyclone is being continually formed in advanced portions of the atmosphere. Since many cyclones are more than one thousand miles in diameter, the difference in the violence of its action on the two sides is very considerable. Hence the interior and most violent portion of a cyclone, always gyrating from right to left in the northern hemisphere, and the contrary in the southern, must always gradually move towards the pole of the hemisphere in which it is. While between the equator and the tropical calm belt, it is carried westward by the general westward motion of the atmosphere there, but after passing the tropical calm belt, the general motion of the atmosphere carries it eastward, and hence the parabolic form of its route is the resultant of the general motions of the atmosphere, and of its gradual motion toward the pole.

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IV. *The Motions of the Ocean.*

38. Besides the actions of the sun and moon which give rise to the tides, there are only two causes which can produce any sensible motions of the waters of the ocean. One of these is the action of the atmosphere upon the surface of the ocean, and the other, the difference of density between the water near the equator and that towards the poles, arising from a difference of temperature. The general motions of the atmosphere at the surface of the ocean have a tendency to cause a westward motion of the water in the torrid zone, and an eastward motion in the middle and higher latitudes; and from what we know of the effects of strong winds upon the ocean, we have reason to think that these general motions of the atmosphere are adequate to produce *sensible* motions, since, after the inertia of the water is once overcome, which, however small the force, is only a question of time, the only force necessary is that which is adequate to overcome the resistance of friction, which is very small where the velocity is small. The difference of density between the equator and the poles causes a slight interchanging motion of the water between them, and consequently, where not interrupted by continents, it produces a system of motions in the ocean similar to those of the atmosphere. Hence these two causes of oceanic disturbance, whatever their relative weight, both act in the same directions, and conjointly cause the observed westward motion of the ocean near the equator, and eastward motion towards the poles.

39. The westward motion of the water of the ocean in the torrid zone was first observed by Columbus, and is now well established; and observations also show that there is a motion towards the east in higher latitudes. A bottle thrown into the ocean near Cape Horn was picked up three and a half years afterward at port Phillip, Australia, a distance of 9000 miles, which makes the eastward velocity in that latitude more than 7 miles per day. And Sir James Ross, when sailing eastward near Prince Edward's Island, found himself every day from 12 to 16 miles by observation in advance of his reckoning. (*Voyage to the Antarctic Seas*, vol. ii, p. 96.) But a westward motion being established in the torrid zone, an eastward motion in the higher latitudes must be admitted; for, as was shown in the case of the atmosphere (§ 13), the one cannot exist without the other.

40. It has generally been supposed that the equatorial westward current of the ocean is caused principally by the action of the westward winds there; but Professor Guyot thinks that "it is too deep and rapid to admit of being explained by their action alone," and that "the difference of temperature betwen the regions near the equator and those near the poles controls all other causes by its power and the constancy of its action." (*Earth and*

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Man, pp. 189, 190.) The torsive or deflecting force which causes the westward motion of the atmosphere and the ocean in the equatorial regions, and the eastward motion in the higher latitudes, has been shown to be as the velocity of the interchanging motion between the equatorial and the polar regions; and hence if this motion in both were similar, the relative amount of this force in each must be as the whole mass multiplied into the velocity of this motion between the equator and the poles. If we suppose the ocean to be 3 miles in depth, its mass is about 500 times that of the atmosphere, and hence if the motion between the equator and the poles were only $\frac{1}{500}$ of that of the atmosphere, the part of the force which gives it a westward motion near the equator, and an eastward motion towards the poles, arising from this cause, must be greater than that of the action of the atmosphere upon it, since the whole amount of this force in the atmosphere is not spent upon the ocean, but only that part which overcomes the resistances to its motions. Although the effect of temperature in producing a difference of density, and consequently of disturbing the equilibrium, is very much less in the ocean than in the atmosphere, yet since the amount of motion which a given disturbing force will produce where time is not considered, depends as has been stated, upon the amount of the resistances, and not upon the amount of inertia to be overcome; and since the resistances diminish as the square of the velocity, a very small amount of disturbing force arising from a difference of density must be adequate to cause an interchanging motion in the ocean between the equatorial and the polar regions equal to $\frac{1}{500}$ of that of the atmosphere; and hence we have reason to think that a greater part of the motions of the ocean is due to this cause than to the action of the atmosphere upon it.

41. The motions of the ocean being similar to those of the atmosphere, they must cause a slight elevation of the surface about the parallels of 30°, and a depression at the equator and the poles, just as in the case of the atmosphere, except that it will be less in the ratio of the relative velocities of the motions of the ocean and of the atmosphere. If we suppose the east and west motions of the ocean to be $\frac{1}{6}$ of those of the atmosphere at the earth's surface, which would require the maximum eastward velocity in the southern hemisphere to be about 10 miles per day, it would cause the surface of the ocean in the southern hemisphere to be about 15 feet higher at the parallel of 30° than at the pole, and also a little higher than at the equator. Now if the motions which cause this accumulation of water were the same at the bottom of the ocean as at the surface, there would be no tendency of the water to flow out at the bottom from beneath this accumulation; but since the motions there must be much less, it must flow out both towards the equator and the pole, especially

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toward the latter, as the depression there is much the greater. Since the density of sea-water does not increase below the temperature of 28°, the density of the ocean does not increase beyond a certain latitude, and hence there is no flow of the water at the bottom from the poles toward the equator, arising from the maximum density at the pole, as seems to be the case in a very slight degree in the atmosphere, but the under current at the bottom, arising from the greater pressure about the parallel of 30°, must extend entirely to the poles; so that there must be a slight tendency of the water to rise at the poles, and flow at the surface some distance towards the middle latitudes. As the water toward the bottom of the ocean is always about the same as the mean temperature of the earth, when it first rises to the surface at the pole, it must be much warmer than it is after it has flowed some distance from it, and hence we have reason to think that there may be open polar seas, surrounded by barriers of ice at some distance from the pole, where there is the maximum temperature of the surface water. A surface current from the poles is indicated by the motions of icebergs in both hemispheres from the polar regions towards a lower latitude.

42. Where the east and west motions of the ocean are entirely intercepted by continents, as in the northern hemisphere, the water receives a slight gyratory motion from left to right. The westward motion of the waters of the Atlantic in the torrid zone, impinging against the continent of America, causes the surface of the water of the Caribbean Sea and the Gulf of Mexico to be a little above the general level, while the eastward motion of the northern part of the Atlantic causes the surface of the water adjacent to the eastern coast of North America, in that latitude, to be a little lower. Hence there is a flow of warm water from the Gulf of Mexico along the coast of the United States toward the lower level about Newfoundland, which, on account of the peculiar configuration of the coast about the Gulf of Mexico, and the peninsula of Florida, gives rise to the Gulf Stream. The eastward motion also of the northern part of the Atlantic causes the surface of the water on the western coast of Europe to be a little *higher* than the general level, while the westward motion in the torrid zone causes it to be depressed, on the western Coast of Africa, a little *below* this level, and hence the water of the eastern side of the Atlantic, flowing from a higher to a lower level, has a motion toward the the equator. The whole of the North Atlantic has therefore a very slight gyratory motion from left to right, and is supposed to make a complete gyration in about three years.

43. A portion of the equatorial current flowing from the higher level of the Caribbean Sea toward Cape Horn causes the Brazil current, which is deflected eastward by the general east-

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ward motion of the Southern Ocean. The east side of the South Atlantic, as well as that of the North Atlantic, seems to have a motion toward the equator. Says Sir James Ross, "There is a current from the Cape of Good Hope along the west coast of Africa 60 miles wide, 200 fathoms deep, with a velocity of one mile per hour, of the mean temperature of the ocean." (*Voyage to the Southern Seas*, vol. ii, p. 35.) This cannot be a portion of the Mozambique current from the warm waters of the Indian Ocean, passing around the Cape of Good Hope, and giving rise to the equatorial current of the Atlantic, as has been supposed, but must come from the colder waters of the Southern Ocean. Hence the South Atlantic also has a tendency to assume a gyratory motion, and the equatorial current of the Atlantic is merely the equatorial portion of these two gyrations, with perhaps a small part of the Mozambique current passing around the Cape.

44. The general eastward motion of the water of the northern part of the Atlantic, and the consequent depression of the water next the coast of North America, is the cause of the cold current of water flowing from Baffin's Bay and the east coast of Greenland, between the Gulf Stream and the coast of the United States called the Greenland current. Since the warm water of the Gulf Stream, in flowing northward, is deflected toward the east (§ 5), and that of the Greenland current, in flowing south, tends toward the west, there is no intermingling of the waters of the two currents, but they are kept entirely separate as if divided by a wall, as has been established by the Coast Survey.

45. There must be a motion of the waters somewhat similar to the Gulf Stream and the Greenland current, wherever the great equatorial current impinges against a continent, and the eastward motion toward the poles is interrupted. Hence, on the eastern coast of South America there is the warm Brazil current which has been mentioned, and on the eastern coast of Asia there is the warm China current, flowing toward the north, similar to the Gulf Stream, and the cold Asiatic current insinuating itself between it and the coast, like the Greenland current. On the east coast of Africa, also, there is the Mozambique current flowing south like the Brazil current, and it is also now well established that, east of the Cape of Good Hope, the general tendency of the water is toward the south. This water must mingle with the general eastward current of the South Sea, and hence there is a slight tendency to a gyratory motion in the Indian Ocean also.

46. On the western sides of the continents there is a motion somewhat the reverse of this, and instead of a warm current flowing north, there is a cold one flowing toward the equator, as has been shown to be the case in the Atlantic. Hence, on the west coast of North America there is a flow of colder water

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along the coast from the north, and on the west coast of South America is Humboldt's current, much colder than the rest of the ocean in the same latitude, both tending toward the equator to join the great westward current there across the Pacific, and to fill up, as it were, the vacuum which this current has a tendency to leave about the equator, on the west coast of America.

47. With regard to the gyratory motion of the oceans, it may be further added here, that such gyrations are clearly demonstrated by the positions of the isothermal lines, as has been shown by Professor Dana, in a paper read at the twelfth meeting of the American Association for the Advancement of Science (*Proceedings*, vol. xii, p. 77). According to this paper, the isothermal line of 68° F., in winter, extends, in the North Atlantic, from 56° N. on the American side, to 12° N. on the African, and in the South Atlantic, from latitude 31° S. on the South American coast, to 7° S. on the African side. Similar evidences are given of gyratory motions, in a less degree, in both the North and South Pacific, and also in the Indian Ocean.

48. When a portion of fluid on the earth's surface gyrates from left to right, the deflecting force arising from the earth's rotation being in this case toward the interior, the surface assumes a slightly convex form. The water of the North Atlantic having a very small gyratory velocity in comparison with that of the earth's rotation, the interior is a little elevated above the general level, and consequently the pressure upon the bottom increased. Now the gyrations which cause this elevation in the middle being principally toward the top, the increased pressure upon the bottom causes the fluid there to flow out on all sides with a very small velocity, towards the circumference, and hence the water at the surface has a slight tendency to flow in from all sides towards the interior to supply its place. This completely accounts for that vast accumulation of drift and sea-weed, covering a large portion of the interior of the North Atlantic, called the Sargasso Sea. From what has been stated, the North Pacific must also have a slight gyratory motion from left to right, and hence it likewise has its Sargasso Sea.

V. *The Motions of Solid Bodies at the Earth's Surface.*

49. It has been shown that if a body were set in motion upon the earth's surface it would move with uniform velocity, but would be continually deflected to one side. When the range of motion is small, $\cos\theta$ (equations (5)) may be regarded as constant, and hence the deflecting force in this case is constant, and must cause the body set in motion to describe the circumference of a circle. If we put ϱ for the radius of curvature, and m for

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the angular velocity about the center of curvature, the centrifugal force of the body is ϱm^2 which must be put equal to the deflecting force, (equation 5). Hence we have

$$\varrho m^2 = 2nv\cos\theta$$

Also, since v is the lineal velocity of the moving body,

$$\varrho m = v.$$

From these two equations we get

$$\varrho = \frac{v}{2n\cos\theta},$$

$$m = 2n\cos\theta$$

50. When the range of motion is so small that $\cos\theta$ may be regarded as constant, ϱ and m are constant, and hence the body then moves with a uniform angular velocity in the circumference of a circle. If we put T for the time of a revolution, we shall have

$$T = \frac{2\pi}{m} = \frac{\pi}{n\cos\theta} = \tfrac{1}{2}\text{ day} \times \sec\theta.*$$

Hence, since v disappears in the result, T is independent of the initial velocity.

51. If a body is forced to move in a straight line F (equation (6)) is the lateral pressure of that body. If we put $v=60$, which is a velocity of about 40 miles per hour, the equation gives $F = \frac{1}{578}g$, at the parallel of 45°. Hence if a railroad train moves in a straight line 40 miles per hour at the parallel of 45°, the lateral pressure is $\frac{1}{578}$ of its weight, and this is precisely the same in all directions, and not in the direction of the meridian only as has been generally supposed.

52. The deflecting force (§ 5) also causes the gyration of a vibrating pendulum. If the pendulum were suspended at the pole it would evidently vibrate in the same plane in space, and consequently perform a gyration in one day. Since the velocity of the earth's revolution around any other point of the earth's surface is $n\cos\theta$ (§ 28), the time of gyration there is $\frac{1\text{ day}}{\cos\theta} =$ 1 day $\times$ sec. θ.

53. This same deflecting force may be used to explain some of the motions of a rotating body. Suppose such a body be placed with its axis of rotation in any direction parallel with the horizon. Then the motions of the upper and lower parts being in contrary directions relative to the earth, and the deflecting force in both being either to the right or the left, according to the hemisphere in which it is, gives the axis of rotation a tendency to assume a perpendicular position. But there are other forces beside these horizontally deflecting forces, so that all the forces

* This result was erroneously given in the Mathematical Monthly, 1 day $\times$ sec. θ.

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which tend to change the position of the axis would not be in equilibrium with the axis in that position. For the equatorial side then would have a motion coinciding in direction with the motion of the earth's rotation, while the other side would have a motion the contrary way, and consequently the centrifugal force arising from the motion of the earth's rotation, combined with that of the rotating body, would be greater on the equatorial than on the polar side, and give the axis of the rotating body a tendency to move in the plane of meridian. It might be easily shown, when the axis has a position parallel with the axis of the earth, that the forces which tend to change its direction are then in equilibrium, and consequently the axis, if free to turn in any direction, does not change its position.

54. These deductions from theory are in exact accordance with some very delicate experiments made by Foucault with a peculiar form of gyroscope, an account of which is given in this Journal, Second Series, vol. xv, p. 263. See also vol. xix, p. 141.

ART. VI.—*Geographical Notices;* by D. C. GILMAN. No. XV.

ARCTIC EXPLORATIONS.

1. *The Hayes Expedition.*—At a meeting of the council of the American Geographical Society, held November 15, 1860, Henry Grinnell, Esq., presented a letter from Dr. I. I. Hayes dated at Upernavik on the west coast of Greenland, Aug. 14, 1860, and reporting the progress up to that point of the Arctic Exploring Expedition under his command. It will be remembered that the particular object which Dr. Hayes has in view is to determine whether or not there is an Open Polar Sea, as Dr. Kane had good reason to believe. The opinions of Dr. Hayes on this subject are set forth in an article from his pen in this Journal, [2] xxix, 401, and more fully in a small volume entitled "An Arctic Boat Journey," (New York, 1859, 12°, pp. 375).

Dr. Hayes sailed from Boston, July 10, 1860, in a small vessel of 140 tons named the "United States," fitted out by the liberality of gentlemen in New York, Boston, Washington, Philadelphia, and other parts of this country, under the auspices, though not under the official responsibility of the American Geographical Society of New York. Every thing had been propitious up to the time of his writing from Upernavik, and Commander and crew were in excellent spirits in view of their long prospective seclusion from the inhabited world. Dr. Hayes still adhered to his plan of wintering at Cape Frazer (lat. 79° 42′).

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The following is his letter:—

Ex. S. United States, Harbor of Upernavik, }
North Greenland, Aug. 14, 1860. }

Gentlemen—I have the pleasure to report for the information of the patrons and friends of the expedition my arrival at this port.

We made a quick passage from Boston. The schooner proved herself to be a good sea boat, and behaved admirably during some very heavy weather. No serious accident occurred.

On the twenty-first day out we were off Godhaven, and on the 5th inst. we anchored in the harbor of Proven. That settlement or outpost in the Upernavik district is forty miles southward from Upernavik. We were there detained in restowing our cargo, so that we might put below, the deck-load of lumber intended for our winter housing, and otherwise better prepare the vessel for the ice encounters. We put to sea again at the earliest practicable moment, and entered this port on the evening of the 12th inst. We found here a Danish brig, belonging to the Royal Company. She will be ready for sea to-morrow, and I shall send my mail by the hands of Dr. Rudolph, the retiring Governor of Upernavik, who returns in her to Copenhagen, and who has politely offered to do me this favor.

Through the kindness and liberality of Mr. Hanson, the Governor of Upernavik, and of Dr. Rudolph, I have obtained at Proven and Upernavik all the dogs that I require, and such furs as are essential to my party. Mr. Hanson and Dr. Rudolph have generously placed at my disposal everything which their personal property or the public stores will afford, for the promotion of the interest of the Expedition.

I have also been fortunate in obtaining the services of an excellent interpreter, Mr. Peter Jonson. He has had much experience in the management of dogs, and is a good hunter. He resides at Tessinsak, sixty miles northward from Upernavik, at which place I shall halt to take on board his team of dogs, which will make, with those on hand, twenty-five.

It is my melancholy duty to report the death by apoplexy, of my carpenter, Gebsen Caruthers. He was found dead in his bunk last Sunday morning. His body was placed in the burial-ground adjoining the church at Upernavik; and I have directed a railing to be constructed around the grave, and a suitable inscription to be placed over it. The loss of Mr. Caruthers is deeply to be regretted. He formerly sailed under Capt. De Haven, in the first Grinnell expedition, and in addition to his experience among the ice and his skill as a workman, he was thoroughly devoted to the best interests of this expedition, and I had great hopes of his future usefulness.

It is impossible for me to predict anything with respect to the prospects before us.

The season has been backward, but the weather has been very mild during the past ten days, and the recent southerly gales have doubtless broken the ice. The wind now blows fresh from the northeast, and if there is much ice before us it will be driven to the southwest.

We shall leave here to-morrow, and attempt at once the Melville Bay passage, and shall hope to make Smith's Strait not later than the 1st of

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Sept. If successful in this endeavor, we shall have abundant time to secure a convenient harbor on the coast of Grinnell's Land. You are already aware that I anticipate (from observations made by myself upon this coast in 1854) reaching Cape Frazer, lat. 79 degrees, 42 minutes, where I propose spending the winter. A degree lower, however, will place one within practicable reach of my proposed field of exploration. If the condition of the ice will permit, I will immediately—after a winter harbor has been selected—carry forward the boat which I intend using for next summer's labors, and some provisions, as far north as possible, and then leave them, secured against the bears, and return to the schooner after the winter has firmly set the ice. Early next spring, we shall push forward advance depots, and should we find either ice or water, we shall endeavor to accomplish with boats or sledges, or with both, the chief object of the voyage before the close of the summer. If this fortune awaits us, we shall then return home without unnecessary delay. I do not, however, anticipate this result, but I expect that we shall be detained two winters.

I shall endeavor by every means to avoid a third year's absence. We carry with us, however, food and fuel for that period, and in the event of our being so long detained I do not fear adverse results. With the fresh supplies we have on board I believe we can resist the scurvy.

I do not hesitate to express my belief that, although we are late, we are in season. Capt. Inglefield left this port on the 16th of August, 1852, and the important results which he achieved during the following month in Smith, Jones and Lancaster Sounds, are well known.

I am informed by Governor Hanson that the whaling fleet did not succeed in passing Melville Bay this year, but you are aware of the fact that after a certain period it would be useless for them to succeed; August is the most open month of the year.

I shall however avoid every unnecessary risk of being caught by the winter in the middle of the ice. Should the prospects of success appear to be peculiarly discouraging, I shall return southward and winter at one of the Danish settlements.

My party are in excellent spirits, and earnest in the performance of their duties, and you may rest assured that no effort will be spared to accomplish the object of our undertaking in the shortest possible time. To favor this, we have every facility which experience has indicated.

Our camp equipments are of the most compact and portable description. The food prepared expressly for the expedition by the American Desicating Company in New York, consisting of soup, beef and potato, is excellent, and fully equals my expectations. Of this food we have three thousand pounds—equal to about thirty thousand pounds of the raw material. I have tried it during the passage, and consider the several articles united preferable to the ordinary pemmican. Pemmican of the finest quality may at any time be made of our beef by the addition of lard, of which we have an abundant supply. With good and sufficient food, with every essential for the promotion of health and comfort, with united and earnest companions, and with a vessel well suited for the service, I have, upon leaving this last outpost of christian settlement, every reason to feel greatly encouraged and to expect success.

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Trusting our lives and fortunes to the keeping of Him who alone is omnipotent, we sever in a few hours our connection with the civilized world, and enter upon our work, looking hopefully to the future.

With the best wishes for the prosperity of you and yours, and with many sincere thanks for the liberality which you and your associates have displayed in our outfit and preparation, I beg you to believe me,

With great regard your obedient servant,

ISAAC I. HAYES.

To Henry Grinnell, Esq., of New York; Richard Baker, Jr., Esq., of Boston; Prof. A. D. Bache, of Washington; Wm. Parker Foulke, Esq., of Philadelphia, and others who contributed to the Expedition.

Almost simultaneously with the receipt of this letter, Dr. William Longshaw, Jr., of East Cambridge, who had left this country with Dr. Hayes as Surgeon to the Expedition, arrived in Boston, having been compelled to return on account of injury to his eye-sight which rendered him nearly "snow-blind." He brought intelligence from Dr. Hayes a few days later than the date of the above letter, and has also communicated to the newspapers of Boston, many interesting details respecting the early part of the voyage, which the limits of this Journal will not allow us to reprint. The expedition sailed from Upernavik, August 14th, for Tessinsak where it had arrived on the 23d of that month. It was here that Dr. Longshaw parted from the company. Dr. Hayes found a small village of Esquimaux at Tessinsak (the home of his interpreter,) some of whom were employed to make up into clothing the furs purchased at Upernavik.

2. *Hall's Search for the Relics of Franklin's Expedition.*—A short time previous to the departure of Dr. Hayes, Mr. C. F. Hall of Cincinnati, conceived the project of searching for further remains of the Franklin expedition. About the first of June, 1860, he set out from New London, in a whaling vessel named the "George Henry" belonging to Messrs. Williams & Haven of that port. A letter just received from him dated at Holsteinberg, Greenland, July 17th, was communicated to the American Geographical Society by Mr. Grinnell, at the meeting above referred to. In respect to the plans and outfit of Mr. Hall we are happy to publish the following information, communicated in a private letter from Henry R. Bond, Esq., of New London, in answer to enquiries which were addressed to him on the part of this Journal.

"New London, Nov. 20, 1860.

* * * Mr. C. F. Hall is a printer who has resided at Cincinnati. He has had no experience whatever as an Arctic explorer, but has always felt interested in northern voyages of discovery and has particularly turned his attention to the various expeditions sent out in search of Sir John Franklin. On the return of M'Clintock's Expedition, he conceived the idea of fitting a

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small vessel and sailing for King Williams Land (where the various Franklin relics were discovered) with the hope of finding some of Franklin's men, still living among the Esquimaux of that region. Being unable to secure funds sufficient for this purpose, he changed his plans and after an interview with Capt. Buddington of this place who was about to sail north on a whaling voyage, he decided with the consent of the owners, to take passage on the "George Henry," (Capt. B.'s ship) and pass the coming winter at that vessel's winter quarters in Cumberland Inlet—there to accustom himself to the climate, and as far as possible, to acquaint himself with the Esquimaux language, and habits of living, which latter he intends to adopt. In the spring he proposes to start in a boat (which he had prepared, and took with him for that purpose) with half a dozen or more picked natives, and plenty of dogs, for King Williams Land. His boat is so arranged, that it can be placed on sledges, so that he can make his way along, by land or water, as required.

After leaving Cumberland Inlet, he will either follow up the east coast of Fox Channel (yet unexplored between 66° 30′ and 70°) to the Straits of the Hecla and Fury, and thence southward and coastwise, until he reaches King Williams Land;—or he will cross Fox Channel at about 66°, thence across Rae Isthmus, by sledges to Committee Bay, and so on by water to his destination. He does not expect to have any white companions, but hopes to be able so to *Equimaux-ise* himself as to be able to communicate personally with, and make himself at home among, such natives as he may meet. He intends to be absent two or three years, during which time he expects to examine carefully King Williams Land, and the main land south, about Great Fish river, for relics of Franklin's Expedition, as he thinks it was not thoroughly explored by Rae or M'Clintock; and he will make particular search among all the natives of that region, for such of Franklin's men as may be still living. Hall takes with him such scientific instruments as he may need, a quantity of provisions, articles of trade for the natives and a full supply of ammunition on which latter he will mainly depend for his subsistence. His expenses are paid by contributions from individuals in Cincinnati, Philadelphia and New York. Messrs. Williams & Haven give him his passage in their "George Henry" to the whaling ground and he expects to make his way back to that point and return home in some whaler when his mission is accomplished.

Hall is physically rather a fat, heavy man, but is full of enthusiasm, pluck and spirit. His enterprise is a very daring one; still if he finds himself able to endure the climate, and the Esquimaux mode of living, he may accomplish something. If he reaches King William's Land in good condition, his chances of discovering other relics seem good." * * *

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From Mr. Hall's letter to Mr. Grinnell we present a few extracts.

Holsteinberg, July 17, 1860.

"Our voyage thus far has been attended with calms, fogs and head winds, thus prolonging it to 39 days. The usual time may be set down at from 25 to 30. We arrived here in Holsteinberg harbor on the morning of July 7. The Rescue, of your first expedition in search of Sir John Franklin, in 1850, arrived at midnight of July 11. The George Henry and Rescue parted company the third night out, during a heavy wind; but Holsteinberg being the rendezvous, each vessel made its course direct here.

My health is excellent—better than ever. I enjoy myself beyond measure.

In this connection, I must speak to you of the coöperation I receive from Capt. Buddington, who has the command of both the George Henry and Rescue. If I could have had the choice of 10,000 men, excellent navigators in the waters of the north, and withal good and true men, I could not have selected a better one than Capt. Sydney J. Buddington. The house of Messrs. Williams and Haven, whose generosity in behalf of my voyage to the north should ever be remembered, know well that their interests in the George Henry and Rescue are in the hands of one of the most careful seamen that comes here in the Arctic seas.

It gives me pleasure, also, to communicate respecting the attention and hospitality extended to me by Gov. Elberg of Holsteinberg.

He, in company with the European ladies of Holsteinberg, have spent several hours on board the George Henry, and in nothing do they seem more interested than in examining the records of the first and second Grinnell Expeditions of 1850–'51, and 1853–'54–'55, as written and illustrated by the lamented Kane. Happily, I had these volumes with me. The Governor was also interested in the work of Captain (now Sir) F. L. McClintock. At a tea-party given by the Governor on the evening of July 10, I was invited to give a general statement of the accomplishments by McClintock, in his last voyage here to the Arctic regions. All were much amazed with the jovialness of Gov. Elberg, in reading before the whole company present McClintock's account of his gift of some coals to "the priest's wife, who was blue with cold." "The priest's wife," Mrs. Kier, was one of the party and seemed to enjoy the joke quite as well as any of us.

I must take the only copy of McClintock I have with me, as there are many statements in it that I wish to investigate personally, when on King William's Land next year.

I have visited various mountains of Greenland during our stay here, and know of no part of the world where there is better opportunity for the geologist to investigate the stratification of the earth's crust than here in the north. By the by, Gov. Elberg has presented me with numerous specimens of fossil fish, from North Strom Fiord, the only place where they can be obtained. Mr. McClintock says they are interesting as being of unknown geological date.*

Before me, on the table in my cabin, where I am writing this, is a beautiful bouquet of Arctic flowers, in great variety, sent me by several young Esquimaux ladies of Holsteinberg. I am astonished at the profuseness of Nature's productions here.

* See this Journ. [2], xxi, 313–338 and xxvi, 119, for age of Arctic rocks.—Eds.

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July 18.—It is intended that we leave here at the earliest moment. Yesterday, by the assistance of Gov. Elberg and Capt. Buddington, I purchased an excellent team of sledge dogs. Next winter will find me half Esquimaux, I doubt not. Capt. Buddington intends finding good quarters for the George Henry, then proceeding with me through Frobisher's Straits and Fox Channel. Circumstances will decide as to penetrating also Repulse Bay. I shall learn much practical information this winter.

July 23, 1 *o'clock*, A. M.—A fresh breeze now prevails. We are now off for the west side of Davis's Straits."

P. S.—Since the foregoing was in type, a later letter has been received by Mr. Grinnell from Mr. Hall. It is written from his proposed winter quarters, lat. 62° 51′ 30″ N., long. 65° 04′ 45″ W., but the day and month are not specified. Hall had lost his expedition boat, but was in good spirits, hoping to prosecute his journey early in the spring. He claims to have discovered that Frobisher's Strait is not a strait but an inlet.

3. *Capt. Parker Snow's Proposal to Search for the Franklin Relics.*—A brief allusion has already been made in this Journal to the desire of Capt. Parker Snow of the British Mercantile Marine, to go in search of the records and other memorials which it is hoped may still be in existence, as relics of the lost Franklin expedition. At the Oxford meeting (1860) of the British Association he presented his views at some length, and his paper together with a report of the comments which it called out, an introduction and an appendix, has been recently published in a pamphlet form. (London, E. Stanford, 1860, 90 pp., 8vo.) Capt. Snow argues with much earnestness that all the information thus far gathered in respect to the fate of Franklin's party indicates that further traces of the expedition must still be in existence near King William's Land, and the peninsula of Boothia. He even thinks that survivors of the party may still be found. Holding these opinions, he desires to go on the search, and appeals to the British public for aid to the amount of £3500, which he thinks will be sufficient to equip a small vessel (say from seventy-five to ninety tons) and maintain a sufficient crew during a period of two years. He states his desire to enter the Arctic seas, through Behring's Straits, hoping to reach King William's Land the first summer.

A writer in the Tribune informs us that on account of inability to raise the funds which he hoped for, Capt. Snow now proposes a well-equipped boat-party, to leave England in the early spring, and reach King William's Land from the East, the sum already collected being sufficient to fit out such a party.

4. *McClintock's Arctic Soundings.*—The London Athenæum for November 17, 1860, contains the following letter from Capt. McClintock, giving some particulars in respect to his attempt to

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make a line of deep sea soundings from Cape Farewell, the southern point of Greenland, to Ireland.

"Bulldog, near Rockall, Nov. 6.
"Closed at Killybeg's, Nov. 11.

"*My dear Collinson*,—We have nearly brought to a close about as *tough a job* as usually falls to the lot of the most hardworking—*even of surveying ships*. I have been up (in the ship) to the head of Hamilton Inlet, but South Greenland we found enveloped in an unusual amount of pack, so much so that I had to go up to Godthaab (64° north) before I could get into any harbor. On the 29th of September I succeeded in getting into Juliansbaab, where I expected to find the Fox, but could obtain no intelligence whatever respecting her. Our vessel was the *earliest* to arrive there this season; the ice having been impenetrable. The Fox (with Capt. Allan Young, Col. Shafner and Dr. Rae on board) had not arrived at Hamilton Inlet on the 17th of September, and I fear she has been detained by ice on the east coast of Greenland, although in a letter Young left for me at Reikiavik he says he intended going *first* to Juliansbaab, to obtain an interpreter for the east coast. We have had desperate weather since the beginning of October. A gale on the 8th of October almost crippled us; we lost two boats, had our bowsprits snapped off by a sea, but as the gammoning held it fast, he has since been 'righted,' and at least *looks* shipshape. The iron tiller was also broken, and a vast deal of damage done to the sponsons, paddle-wheels, bulwarks, &c., lying to under bare poles for thirty hours, sleet aloft, and seas coming over us below, unable to cook, &c., disagreeable enough even for a '*Polar*.' To accomplish a line of soundings from Cape Farewell to Rockall, has proved rather beyond our powers at this late season, and with such continued severe weather; yet we have sounded at intervals the whole way, and I think sufficiently for ordinary purposes. Southwest of Iceland, where we expected 2,000 fathoms, we only found 748 fathoms, and in 1,260 fathoms we brought up a living star-fish! I tried in July, August, September and October, yet could not approach Cape Farewell from the southwest, within forty-five miles, the intermediate space being close pack; but at the same time the present is such a bad year that the Danes in Greenland say that they have not had one like it for nearly thirty years. It has been very favorable in Labrador, and very little ice is seen there. In Iceland also, the summer has been very fine. We have had much more icework than I expected, and the ship has suffered accordingly; paddle-arms bent, cutwater chafed away, and copper bolts standing out; the ship rolls very heavily, and is now quite *eager* for a good caulking. I think we have done our work well; at least we have done all we can. Instead of a deep channel leading into Hamilton Inlet, I doubt if forty-five fathoms can be carried inside the outer Islands, and would reduce the width of the main channel to about five miles, and there is an exterior bank along that part of the coast, having between 100 and 200 fathoms water on it. * * I have completed the soundings across to Rockall, but they are at long intervals, and not as straight in line as they would have been under more favourable circumstances of weather. I obtained deep water again inside of the Rockall Bank, 1,310 fathoms about mid-

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way. * * The same southeast wind is still blowing which has scarcely ceased since the 18th of October.—Most sincerely yours,

"F. L. McClintock, R. N."

Heuglin's Search for Dr. Vogel, in Central Africa.—The fate of Dr. Edward Vogel, who set out in 1853, under the patronage of the British Government, to coöperate in the explorations of Central Africa then already undertaken by Richardson, Barth, and Overweg, has remained until the present time shrouded in complete mystery. This brave young man, the third son of Dr. Charles Vogel, a distinguished School Director in Leipsic, landed at Tripoli on the 7th of March, 1853, (his twenty-fourth birth-day) and began his African researches. On the first of January, 1856, he set out from Kuka, on the western shore of Lake Tsad intending to return to Europe by way of Wadai, Darfur, Kordofan and the Nile. The items of intelligence which have since been gathered from various sources give reason to believe that he reached the capital of Wadai, *Wara*, and that he was beheaded by the Sultan of that land, although indeed there is a possibility that he is still imprisoned in that country. Every effort to gain more definite information has hitherto failed.

By the kindness of Dr. A. Petermann, of Gotha, the editor of the Geographische Mittheilungen, we have been informed of a noble project, recently put forth, for enlisting the people of Germany in a special expedition, of which the object will be to determine if possible the fate of Dr. Vogel, to recover any remains which may be in existence of his journal and observations, and to prosecute those geographical and scientific inquiries to which his life has in all probability been an offering.

Fortunately the right man is known for this bold and difficult enterprise. Mr. Theodore von Heuglin, for seven years Austrian Consul at Chartum on the Nile, a traveller and observer whose writings are well known in geographical literature, stands ready to go forth in search of tidings of his countryman. A committee of which the Duke of Saxe-Coburg-Gotha is the President, Justus Perthes the Treasurer, and Dr. Petermann the Secretary, has recently been organized, and is diligently engaged in enlisting the sympathies and securing the aid of liberal Germans in promoting researches which the dictates of humanity as well as the interest of science so loudly call for.

From the various circulars which this committee have put forth, we gain the following additional particulars. Mr. von Heuglin is said to be qualified for his proposed task in all the most important requisites of an African explorer. He is accustomed to the climate, acquainted with the languages and habits of the natives, skilled in astronomical and geographical observations,—a good draughtsman, and by his previous residence and travels in Africa known to many influential persons.

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Mr. von Heuglin proposed to leave Europe last autumn, and since in Cairo and Chartum he is acquainted with trustworthy servants and has a supply of scientific instruments, he will make the Nile lands the basis of his enterprise, endeavoring at the same time, to have reserved supplies at Bengasi, a town on the North African coast which has direct commercial relations with Wadai. He proposes, if pecuniary resources allow, to secure the services of a botanist as a companion. It is thought that three or four years will be occupied by the expedition, and that its entire cost, in addition to the private resources of the explorer, will fall between twelve and twenty thousand thalers. At the date of our last advices about one third of the necessary amount had already been secured, wholly from the German compatriots of Heuglin and Vogel. As the enterprise is regarded in "the fatherland" as an expression of national union in the advancement of science, we cannot but hope that among the adopted citizens of this country from Germany, so many of whom have acquired ample fortunes, there will some men of liberality be found ready and eager to aid in carrying forward a project which is full of promise.

MEDICAL STATISTICS OF THE U. S. ARMY.—The Surgeon General of the U. S. Army, Gen. Thomas Lawton, has recently presented to Congress a statistical report on the sickness and mortality of the United States Army, between Jan. 1855, and Jan. 1860, prepared by Dr. R. H. Coolidge, Assist. Surg. U. S. A. Although this document is chiefly devoted to sanitary discussions, it is of great value to the student of the physical characteristics of this continent, from the light which it throws on the geographical distribution of various forms of disease.

Two such reports have previously been printed, the first covering a period of twenty years, from 1819 to 1839, and the second a period of sixteen years, from 1839 to 1855. This may be considered accordingly as a supplement or continuation, the general arrangement before adopted being still adhered to, that is, the details being arranged in geographical divisions and regions having similar climatological features.

The volume is accompanied by an outline map of the United States, on a scale of 1 : 10,000,000, being unincumbered with the ordinary topographical details, and political divisions,—it presents to the eye in a very clear and satisfactory manner the limits of the seven military departments of this Government, the East, the West, Texas, New Mexico, Utah, Oregon and California, and also indicates the site of all military posts, both forts and arsenals throughout the entire country.

SQUIER'S COLLECTION OF ORIGINAL DOCUMENTS CONCERNING THE DISCOVERY OF AMERICA.—Mr. E. G. Squier, well known

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for his archæological attainments and his printed works in reference to the early history of America, has announced the publication of a series of papers, chiefly from the Spanish archives, concerning the discovery and conquest of America, which he proposes to issue in the original, with translations, illustrative notes, maps and biographical sketches. The materials for the series have been collected, partly from the Spanish archives, and partly from Central America, during a period of ten years' study of American archæology. The scheme is deserving of the utmost encouragement, as under any circumstances it must appeal to a limited circle of students. The collection will be indispensable to the geographical or historical student, and an honorable companion and supplement to the great collections of Ternaux-Compans, Munoz and Navarrete. The proposal of Mr. Squier to print the original document as well as the translation in every case, will meet with universal acceptance. The first volume of the series, containing Palacio's description of Guazacapan, Izalco, Cuscatlan, Chiquimula, in 1576, has already appeared. Subscriptions for this and the subsequent volumes may be addressed to the Editor, Mr. E. G. Squier, 205 East Tenth Street, New York.

Among the manuscripts collected for publication are the following:

I. Carta dirijida al Rey de España por el Licenciado Don Diego Garcia, de Palacio, Oydor de la Real Audiencia de Guatemala, año 1576.

Report on the Provinces of Guazacapan, Izalco, Cuscatlan, and Chiquimula in the ancient Audiencia of Guatemala, with an account of the languages, customs, and religion of the aboriginal inhabitants, and a description, the first ever given, of the Ruins of Copan. ***Original Spanish, Translation and Notes, with a Map.***—(Ready.)

II. Relacion del Descubrimiento y Conquista de las provincias de Nicaragua, dirijida al Rey de España, por el Capitan Gil Gonzalez Davila, desde la Ciudad de Santo Domingo de la Isla Española, 6 dias del mes de Marzo, de 1524 años.

Gil Gonzalez Davila was the first discoverer and conqueror of Nicaragua, and this is an account, under his own hand, of the circumstances of its reduction, and of the character of the country and its inhabitants. Although largely used by Oviedo, Peter Martyr, and Hererra, it has never been published.

III. Cartas del Adelantado Don Pedro de Alvarado, escrita al Rey de España y al Capitan Hernando Cortez, sobre la Conquista y Pacificacion de los Reynos de Guatemala, y la Expedicion que hizo desde el Puerto de Iztapa á Peru, etc.

These letters of Don Pedro de Alvarado, the celebrated Lieutenant of Cortez in Mexico, the Conqueror and afterwards Royal Governor of Guatemala, are seventeen in number, of which three only have been printed. They give an account of the reduction of the rich and powerful Kingdoms of the Zutugils, Quichés, and Kachiquels of Guatemala, and also of his campaign against the Pipils of Cuscatlan (now San Salvador), and his Expedition to Peru.

IV. Relacion muy circumstanciada, escrita al Rey, de los sucesos de Juan Vasquez de Coronado, en las Provincias de Nuevo Cartago y Costa

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Rica en la Pacificacion y Descubrimiento de ellas, por el Cabildo de la Ciudad y Provincia de Costa Rica, en 12 de Diciembre, 1562.

A very circumstantial relation to the King of the proceedings of Juan Vasques de Coronado, in the Provinces of New Cartago and Costa Rica, and in their reduction and pacification, by the Municipality of the City and Province of Costa Rica, December 12th, 1562.

V. Relacion dirigida al Rey por Pedrarias Davila, de las Tierras, Costas y Puertos que estaban descubiertos en el Mar del Sur, desde la Villa de Bruselas que estaba poblado en el Golfo de San Lucar, hasta Neguepio que por otro nombre tambien se llamaba Cuzcatan, distancia de 200 leguas; año 1529.

Relation to the King of Spain, by Pedro Arias de Avila, concerning the lands, coasts, and ports which have been discovered in the South Sea, from the city of Brussles in the Gulf of San Lucar, to Neguepio, called also Cuzcatan, a distance of 200 leagues. Dated in the year 1529.

VI. Relation que en el Consejo Real de las Indias hizeo el Licenciado Antonio de Leon Pinelo, Relator de su Alteza, Sobre la Pacificacion y Poblacion de las Provincias del Manché i Lacandon, que pretende hazer Don Diego de Vera Ordoñez de Villaquiran, Cavallero de la Orden de la Calatrava, etc.; año 1638.

This is an account drawn up by the celebrated Antonio Leon Pinceo, author of the "Tratado de Confirmaciones Reales, etc," in his capacity of historical Secretary or reporter to the Council of the Indias, on the remarkable and even now but little known district, occupied by unconquered Indian tribes, which lies between Guatemala, Chiapa, Tabasco, and Yucatan. It gives a comprehensive summary of all that was known of this wide region and its inhabitants, at the time Pinelo wrote, and seems to have been compiled from original, and, as yet, unpublished, documents in the Archives of the Indies. These *relaciones* or Briefs were for the use of the Council exclusively, and only enough were printed to give a copy to each member. Probably no copy of the present document exists, except the one under notice, which seems to have belonged to Pinelo himself, as may be inferred from the MS. corrections and emendations which it bears, and which appear to have been made by his own hand.

VII. Carta dirijida al Rey de España sobre la Conquista y Pacificacion de la Provincia de Yucatan y sus poderosos Reyes, por el Fray Lorenzo de Bienvenida; año 1548.

VIII. Relacion de la Provincia de Honduras ó Higueras, por el Obispo Don Cristoval de Pedraza, Obispo de Honduras, dirijida al Emperador, desde el puerto de Truxillo, con fecha de primero de Mayo, año 1547.

IX. Descripcion de las Islas Guanajas; parte de un Informe hecho en 1639, de orden del Presidente de Guatemala, por Don Francisco de Avila i Lugo, Gobernador i Capitan General de Honduras.

X. Relacion de la provincia y tierra de la Vera Paz, y de las cosas contenidas en ella, como son montes, fuentes, animales, aves, y plantas y arboledas, del numero de los pueblos y distancia de la Iglesias y fundacion de ellas, y de lo que cada uno tiene; y finalmente del numero de gente, sus lenguas, su policia y Xpiandad, desde el año de 1544, hasta este de 1575.

XI. Discurso de Felipe de Aniñon, sobre las utilidades y ventajas que resultarian de mudarse la Navegacion de Nombre de Dios y Panama al Puerto de Cavallos y Fonseca, año 1565.

Etc., etc., etc., more than one hundred in number.

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ART. VII.—*Researches on the Platinum Metals;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy, New York.

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§ 1.

THE material which formed the subject of the present investigation was chiefly obtained from the United States Assay Office and from the Philadelphia Mint, and I am indebted for it to the kindness of Dr. Torrey and of Prof. Bache. Messrs. Cornelius of Philadelphia have also liberally presented me with about 600 grammes of the Siberian osmiridium—a supply which has been of great assistance and for which I desire to express my thanks. The samples obtained from the mint at different times and which had been subjected to different preliminary processes, varied greatly in appearance. In some cases the ore was in distinct scales rather whiter than the Siberian osmiridium; in a sample of this kind Dr. Genth detected distinct crystals, belonging to the rhombohedral system. Other specimens resembled a fine grey metallic sand, while others again (obtained from the sweepings of the Assay Office) presented a heavy grey powder. Nearly all the ores contained more or less iron mechanically mixed which could be extracted by the magnet or dissolved out by acids. Nitro-muriatic acid in particular acted powerfully upon many specimens, dissolving portions of the platinum metals as well as iron and even so far attacking the osmiridium itself as to occasion a distinct evolution of free osmic acid. In California the ore is, I believe, almost always associated with gold, from which it is of course impossible to separate it by washing. At the Assay office, in this city, the gold is melted with twice its weight of silver and the osmiridium allowed to settle. When the gold alloy is poured off, there remains a mass containing nearly all the osmiridium mixed with gold. This mass is fused repeatedly with silver and the last traces of silver and gold are finally removed by treatment with nitric and nitro-muriatic acid and washing. The osmiridium is sold to the manufacturers of gold pens who extract from it the excessively hard particles which serve for the points of pens: the rest is returned to the assay office. The amount of osmiridium obtained in this way does not exceed a few ounces in every million of dollars, and many samples of gold are entirely free from it. It cannot however be doubted that large quantities of the ore will be obtained whenever important practical applications of the metals contained in it shall create a demand.*

* Dr. Torrey has kindly furnished me with the following notes on the Californian osmiridium. "For the first year or two after the establishment of the United

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The density of the osmiridium obtained from California varies greatly in different samples: in one specimen, composed of large dull white plates but slightly acted on by nitro-muriatic acid, the specific gravity as determined by Rose's method was found to be 19·352. No very definite conclusions can be reached however from such determinations, since, as Berzelius has remarked, the separate scales or grains have probably very different compositions. According to G. Rose, the density of the Siberian ore varies from 19·3 to 21·1. Dr. Torrey has found among the scales of the Californian ore some which could be flattened under the hammer; these were probably platin-iridium. In general, however, the scales are not malleable; some of a lead gray or bluish tint being with great difficulty cut by the emory dust employed by the gold pen makers. In color the scales vary from nearly silver white to dark gray.

§ 2.

The resolution of the ores of iridium, osmium, etc., and the separation of the different platinum metals from each other, have as is well known always been considered as among the most difficult problems with which the chemist has to deal. Though the researches of Wollaston, Berzelius, Wöhler and other chemists have thrown much light on the subject, and though Claus, in particular, in his elaborate "Beiträge zur Chemie der Platin-Metalle" has done much to free the chemical history of this group from the errors of his predecessors, I yet found that much remained to be done, especially as the Californian ore differs from the Siberian in the greater relative proportion of Ruthenium which it contains. This difference alone renders a different treatment of the ores necessary. In the course of the investigation which I have undertaken, I have been able to test upon considerable quantities of material, nearly all the methods of working the ores of osmium, etc., which have hitherto been employed. As the experience thus obtained has been at great expense of time and labor I will here give it as concisely as possible, believing that it will be useful to others, who may hereafter take up the same subject.

States Assay Office, the proportion of osmiridium in the California gold, did not exceed half an ounce to the million of dollars. Afterward, the proportion rapidly increased till the average was seven or eight ounces to the million of gold. Then for a year or more the quantity diminished, but for the last year it has been as large as ever. These differences depend upon the variable composition of the native gold, and the constant discovery of new diggings.

The grains of osmiridium, suitable for pens, are roundish and solid, not liable to exfoliate when struck or heated. They seem to have a different composition from the compressed and tabular crystals. The proportion of them is usually not more than a tenth of all the alloy, but it is sometimes as large as one-fifth.

The carefully selected grains used by the gold pen makers are so minute that from 10,000 to 15,000 of them are contained in a single ounce. The very best are worth at least $250 an ounce, and a cubic inch, which would be equal to about eleven ounces, is worth $2,750.

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Fremy's* most recent method consists in roasting the ore in a current of air or oxygen at a strong red heat. Under these circumstances the osmium is in a great measure removed as osmic acid, while the other metals are more or less completely oxydized. The mass from which the osmium has been removed is then to be fused with nitre, after which the remaining osmium may be separated by distillation with nitric acid. Fremy gives a method for the separation of the other metals from each other, which however cannot yield these in a state of purity. The separation of the osmium by roasting, has undoubtedly the advantage of giving pure osmic acid in large quantity and at small expense of materials. On the other hand, this process is not applicable to all the varieties of osmiridium, while in those to which it does apply the roasting does not remove all the osmium, and consequently does not obviate the necessity of one or more subsequent fusions with powerful oxydizing agents. So far as the iridium, rhodium and ruthenium are concerned, it is better to oxydize at once as Claus recommends, by fusion with nitre and caustic potash. In an experiment which I made to test Fremy's process and in which I employed California ore in the form of fine gray sand and heated to full whiteness in a porcelain tube, I obtained after long heating but little osmic acid; the tube became clogged and broke, and after cooling I found that the ore had actually melted and presented a gray mass, having the shape of the tube in which it was fused. This mass resembled when broken a fine grained cast iron; it was very hard and distinctly crystalline upon those parts of the fracture nearest the surface. As the large scales of osmiridium from California do not melt before the flame of the compound blowpipe this result was very unexpected; it was doubtless owing to the large quantity of iron which the ore contained.

In a memoir published in 1835, Persoz† gave a method of working osmiridium by first converting the metals into sulphids. The ore is to be mixed with carbonate of soda and sulphur and then projected into a strongly heated earthen crucible. The crucible is then to be heated to whiteness, allowed to cool and broken. According to Persoz, the contents of the crucible consist of three layers, of which the lowest contains nearly all the sulphids of the platinum metals. The two lower layers are to be treated with water to dissolve the alkaline sulphids, and the remaining mass heated with oxyd of mercury which leaves oxyd of iridium—according to Persoz—while oxyd of osmium and metallic mercury are expelled.

* Comptes Rendus, xxxviii, 1008.

† Ann. de Chimie et de Physique, 55, 210.

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Weiss and Doebereiner* confirmed the results of Persoz so far as the conversion of the platinum metals into sulphids was concerned. They recommended the fusion of the sulphids, after removing those of sodium and of iron by washing with water and chlorhydric acid, with carbonate of potash and saltpetre, so as to oxydize the sulphur and the platinum metals at the same time. By this process the ore is almost completely resolved in two operations.

On repeating these experiments with the California ore, I obtained the same results as to the formation of the metallic sulphids. After digesting the fused matter with chlorhydric acid and washing, there remained a greyish mass of crystalline scales, which resisted even boiling nitro-muriatic acid,—no smell of osmic acid being perceptible. These scales were however powerfully acted upon by fused caustic potash to which saltpetre was cautiously added, or by a mixture of carbonate and nitrate of potash, but the process could only be conducted on a small scale in consequence of excessive frothing which rendered it necessary to use very large vessels. Chlorine gas at a red heat exerted no sensible action upon the mixed sulphids.

The difficulties attending the fusion of the mixed sulphids with oxydizing agents may however be readily overcome by previously reducing them to the metallic state. This is most simply accomplished by a method suggested to me by Dr. Genth, which consists in evaporating the sulphids to dryness with a small excess of strong sulphuric acid and then igniting gently. A gray metallic sponge remains, which contains all the platinum metals with a small quantity of iron. It is easily reduced to a fine powder by rubbing in a mortar and may then be completely oxydized by Claus' method presently to be described. Nitro-muriatic acid acts very slightly upon this metallic mixture and I have not found it possible by this agent to remove an appreciable trace of platinum.

This process when carefully conducted gives good results but is not free from inconvenience. In the first place the treatment of the mixed sulphids with sulphuric acid must frequently be repeated twice in order to ensure the complete conversion of the sulphids into metals. Again the action of a mixture of caustic potash and saltpetre at a high temperature upon the finely divided metallic mass is violent and not free from danger when all the materials are heated together. The danger may be avoided by fusing the nitre and potash together and, after all frothing has ceased, projecting the metallic sponge little by little into the crucible, waiting in each case until the resulting action has ceased before projecting a fresh portion. I am of opinion that the pre-

* Annalen der Pharmacie, xiv, 15.

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vious conversion of the platinum-metals into sulphids and subsequent reduction to the metallic state is upon the whole more inconvenient and requires more time than the direct resolution of the ore by fusion with an oxydizing mixture.

Experiments which I have instituted upon the effects of fusing the ore with steel, phosphorus, arsenic and sodium, led to no really valuable practical results. It is true that an alloy with steel can be obtained by fusion at a high temperature. Acids slowly dissolve the iron in this alloy and leave the platinum metals in the form of a black powder which is attacked by nitro-muriatic acid, though not completely dissolved. But the process is tedious and the results not very satisfactory.*

Wöhler's† method of resolving osmiridium, consists in passing moist chlorine over the ore mixed with common salt and heated to low redness in a glass or porcelain tube. This method is invaluable in analysis and gives excellent results in working the ore upon a small scale. In all cases however, several repetitions of the process are necessary for complete resolution or reduction to a soluble form. On the other hand, it can scarcely be doubted that this method could be advantageously employed upon the large scale, if vessels of porcelain of large size and of a proper shape could be obtained. Such vessels might be constructed in the form of long and flattened ellipsoids, furnished at each extremity with wide tubes several inches in length, and would be of great utility in various chemical processes. No process of fusion with oxydizing agents compares with Wöhler's method in point of elegance, as no iron or other impurities afterward to be removed, are introduced by the process itself.

Fritzsche and Struve‡ treat the ore with a mixture of equal parts of hydrate and chlorate of potash, by which a more or less complete oxydation is effected, without any sensible evolution of osmic acid. The temperature required in this process is not high, but large vessels must be employed as the mixture froths very much at first. The process in question has not appeared to me to possess any sensible advantage over that of Claus, which is moreover less expensive and can be carried out with smaller vessels.

Claus'§ method of resolving the ore consists in fusing for an hour, at a red heat, a mixture of one part of ore with one part

* Since the above was written the elaborate memoir of Deville and Debray on the platinum metals has appeared. (Ann. de Chimie et de Physique, 3d, lvi, 385.) I have not however been able to repeat any of the processes for subdividing or oxydizing osmiridium given by these chemists but consider it probable that the subdivision of the ore accomplished by fusion with zinc may be simpler than that which I have described above.

† Pogg. Annalen, xxxi, 161.

‡ Journal für prakt. Chemie, xxxvii, p. 483.

§ Beiträge zur Chemie der Platin-metalle. Dorpat, 1854.

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of caustic potash and two of saltpetre. The fused mass is to be poured out upon a stone, allowed to cool, broken into small pieces or powdered, and then introduced into a flask which is to be filled with cold water and allowed to stand for twenty-four hours. The clear deep orange red solution of osmate and ruthenate of potash is then to be drawn off by means of a syphon, and the black mass remaining again washed in the same manner. The finely divided oxydized portion of the insoluble matter may now be separated from the unattacked ore by diffusion in water and pouring off, after the subsidence of the heavier ore. The unattacked ore is then to be fused a second time with potash and saltpetre and treated as before. Claus asserts that he has been able in this manner to resolve the Siberian osmiridium completely in two operations.

I have not always been so fortunate with the raw California ore, even when in a finely divided state. On the contrary, after three or four successive fusions there usually remained a large quantity of black matter insoluble in aqua-regia. In one operation with 500 grammes of ore only 200 grammes were rendered soluble by two fusions with potash and saltpetre. I employ at present the method of Claus with several modifications which I deem essential. The ore, which is usually very impure, is in the first place to be fused with three times its weight of dry carbonate of soda. The fused mass after cooling is to be treated with hot water to remove all the soluble portions and then the lighter portions are to be separated by washing from the heavy unattacked ore. In this manner the greater part of the silica and other impurities present may be removed. A previous purification of this kind is not indispensable and may be omitted altogether when the ore is in plates or large grains, but it is very desirable when the ore is fine powder and greatly facilitates the subsequent action of the oxydizing mixture. Claus recommends the purification of the ore by boiling with a solution of caustic potash. It is certain that a much larger portion of the ore is resolved by two successive fusions with potash and nitre after previous purification by fusion with soda and washing. By cutting off the top of a mercury bottle a wrought iron crucible is obtained in which 600 grammes of osmiridium may be fused at one operation with potash and saltpetre as above. There is usually little or no foaming and if any occur it may easily be checked by stirring with an iron rod. No sensible quantity of osmic acid is given off during the process, which with a little care is entirely free from danger. In this manner, I have worked up 1500 grammes of ore in a few hours in three successive operations.

Claus' method of treating the fused mass to separate ruthenium and osmium is liable to two sources of inconvenience. In

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the first place, the quantity of water required to dissolve out the soluble portions is very large, and the subsequent treatment of such bulky solutions by distillation with acids, tedious—very large retorts being necessary. In the next place, it is impossible in this way to avoid exposure to the vapor of osmic acid, especially in transferring the solutions from one vessel to another. I therefore prefer the following process which leaves nothing to be desired in point of safety or convenience. The fused mass is to be broken into pieces with a hammer and brought into a clean iron pot—a common skillet with a long handle answers this purpose extremely well. Boiling water containing about one-tenth of its volume of strong alcohol is then to be added and the whole is to be boiled over an open fire until the fused mass is completely disintegrated. The osmate of potash is in this manner reduced to osmite $KOsO_4$, while the ruthenate of potash is completely decomposed, the ruthenium being precipitated as a black powder—probably a mixture of RuO_2 and Ru_2O_3 or of the hydrates of these oxyds. It is advantageous, after boiling for some time, to pour off the supernatant liquid with the lighter portions of the oxyds and boil a second time with a fresh mixture of alcohol and water. In this manner we obtain a solution of osmite of potash, a large quantity of black oxyds and a heavy black and coarse powder. This last consists chiefly of undecomposed ore mixed with a small quantity of the oxyds of iridium &c., with scales of oxyd of iron from the crucible and, if the ore has not been previously purified, with the impurities of the ore itself. The greater specific gravity of this residual mass renders it very easy to pour off from it the mixture of black oxyds with the solution of osmite of potash and alkaline salts. This solution with the suspended powder is to be poured into a beaker and allowed to settle. The heavy black powder remaining in the iron pot is then to be perfectly dried over the fire and fused a second time with potash and saltpetre as before. The fused mass is to be treated exactly as after the first fusion. The heavy portions remaining after this operation may be fused a third time with the oxydizing mixture. When however the ore has been previously purified by fusion with carbonate of soda, or when it was originally in the form of clean scales, the heavy portion remaining after two successive oxydations will be found to consist chiefly of scales of oxyd of iron.

The solutions containing osmite of potash and alkaline salts are to be carefully drawn off by a siphon from the black oxyds which have settled to the bottom of the containing vessels. The oxyds may then be washed with hot water containing a little alcohol and introduced into a capacious retort. By this process, when carefully executed, no trace of osmic acid escapes—an advantage not to be despised, as the deleterious effects of this body

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upon the lungs have not been exaggerated and too much care cannot be taken to avoid inhaling it.

The solution of alkaline salts contains only a portion of the osmium in the ore. The other portion exists in the mixture of oxyd and must be separated by distillation. For this purpose the retort should be provided with a safety tube passing through the tubulure and with a receiver kept cold, and connected by a wide bent tube with a series of two or three two-necked bottles containing a strong solution of caustic potash with a little alcohol and also kept cold. All the tubulures and connections must be made perfectly tight. Strong chlorhydric acid is then to be cautiously poured into the retort through the safety-tube in small portions at a time. The reaction which ensues is often violent; great heat is evolved and a portion of the osmic acid distils over immediately and condenses in the receiver in the form of colorless needles. When a large excess of acid has been added, the action has entirely ceased and the retort has become cold, heat may be applied by means of a sand bath. The osmic acid gradually distils over and condenses in the receiver and in the two-necked bottles. Especial care must be taken that the beak of the retort is not too small at the extremity as it may otherwise become completely stopped up with the condensed osmic acid. The same applies to the tubes connecting the receivers and two-necked bottles. The distillation should be continued for some time after osmic acid ceases to appear in the neck of the retort; when this has once become hot the acid condenses and passes into the receiver in the form of oily drops.

When the distillation is finished the retort is to be allowed to cool and then separated from the receiver which is to be immediately closed with a cork. By gently heating the receiver in a water-bath the contained osmic acid may be driven over into the two-necked bottles where it condenses in the alkaline solution and is reduced by the alcohol to osmite of potash. The solution thus obtained may be added to that obtained directly from the fused mass of ore and on evaporation in a water-bath and cooling will yield crystals of osmite of potash, the salt being but slightly soluble in strong saline solutions. The mother liquor from the crystals contains only traces of osmium and may be thrown away as worthless.

The dissolved portions drawn off from the retort have a very dark brown-red color. The solution is to be evaporated to dryness, redissolved in hot water and again evaporated, after adding a little chlorhydric acid, and this process repeated till no smell of osmic acid can be perceived. A cold and saturated solution of chlorid of potassium is then to be added in large excess. This dissolves the chlorids of iron and palladium which may be present, leaving platinum, iridium, rhodium and ruthenium as double chlorids insoluble in a strong solution of the alkaline chlorid.

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The undissolved mass is to be well washed with a saturated solution of chlorid of potassium which, for reasons hereafter to be mentioned, is preferable to salammoniac. In this manner nearly the whole of the iron and palladium may be removed, while any insoluble impurities contained in the ore remain with the mixed double chlorids.

New York, Oct. 31st, 1860.

(*To be continued.*)

ART. VIII.—*On a Method of Producing Stereographs by Hand;* by OGDEN N. ROOD, Prof. of Chemistry in Troy University.

[With a Stereoscopic diagram.]

SIR DAVID BREWSTER in his *Treatise on the Stereoscope*, (London, 1856) page 135, after describing a method of projecting the picture seen by one eye, of a symmetrical, geometric solid, and of obtaining by reflexion from a mirror a drawing of its stereoscopic companion, states: "When the geometrical solids are not symmetrical, their dissimilar pictures must be taken photographically, from models, in the same manner as the dissimilar pictures of other solids."

Upon page 200 of the same work he states, that though apparatus may be photographed *directly*, yet that stereoscopic diagrams, can only be executed by the use of models made of *wire*, which are to be photographed in the usual way.

The same author in the article Stereoscope, *Encylopædia Britannica*, vol. xx, 1859, p. 690, writes: "As no artist, however skillful, is capable of executing two pictures of any individual object, or group of objects, as they are seen by each eye separately, the stereoscope was of little value before the art of photography enabled us to take such pictures with the most perfect accuracy."

In addition to these statements, which would seem to imply the impossibility of producing stereographs by hand, I have not been able to learn from scientific friends nor from professional photographers, that any process is now in use to effect this end, except the laborious and imperfect one of geometrical *projection*. Under these circumstances, I venture to describe a simple method of drawing stereographs, which possibly may supply a want in this department.

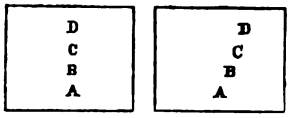
When we examine attentively a photographic stereograph with the aid of micrometrical measurements, and adopt the left-hand picture as a *standard of comparison*, we find that the right-hand picture is an exact reproduction of it, with one important exception; viz., that in the right-hand picture the position of an object, a little more distant from the spectator than the immediate foreground, is *shifted* a small distance toward the right

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hand; objects farther back, have their position shifted still more to the right hand, &c.

This is illustrated by fig. 1, where A is in the immediate foreground, and D in the background.

1.



Now if we had a single drawing in perspective, of a house for example, and could produce a fac-simile of it, this would evidently answer for the left-hand picture. If we could again reproduce this drawing on the right hand of the slide, with all the objects or points in it back of the immediate foreground, *shifted* to the right hand the proper distances, we should have a pair of pictures, which when combined in the stereoscope would give relief.

To accomplish this is the object of the machine seen in fig. 2.

2.



It consists of a board, 10 in. by 14, having a square opening O, in its centre 5 inches wide; this is covered by a plate of glass which is let into the wood and lies even with its upper surface. The slider C is moveable in the direction indicated in the figure: its motion is effected by the screw A, which acts against the India rubber band I: the screw and its support are removable at pleasure. The mirror M serves for illumination; the shade B moves on hinges, and regulates the amount of light which falls on the paper while the drawing is being made.

To produce a stereograph, the object or objects to be represented are drawn in perspective with ink on writing paper; this is oiled to render it transparent, the excess of oil is removed, and the drawing is attached with a drop or two of gum arabic to the glass plate, which is completely exposed by the removal of the slider. The under side of the latter is covered with ordinary writing paper or with thin paper, and it is slid into the machine till the drawing is seen under its left half, the screw having been previously removed. In this position it is fastened securely by a screw at C, and the drawing is traced slowly, line by line, until as perfect a fac-simile as can be made by hand has been produced; this is the left-hand picture.

The slider is now moved toward the right hand a distance of 2·6 in. and the screw with the India rubber band attached.

An object, or a small portion of an object, in the *immediate foreground* is now traced, then the screw is turned slightly so as throw the next object, or the remainder of the first object, slightly toward the right hand where it also is drawn, &c. Thus we advance slowly toward the background, turning the screw

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each time that depth is to be represented. This in practice is a very simple operation, and if the displacements toward the right hand have been rightly proportioned the effect produced is good.*

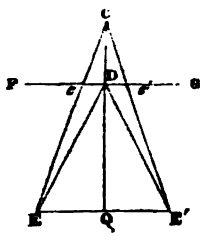
The process is also a rapid one, for it consists only in making two tracings.

The question now arises as to the total amount of displacement allowable, and as to its proper distribution.

If a number of stereoscopic photographs are examined it will be found that in those where the sum of all the displacements is not more than one or two tenths of an inch the two images are readily united, and a good general effect produced, while in those where this quantity is as great as three or four tenths, difficulty is experienced in effecting the union.

Taking then ·2 of an inch as the maximum total displacement allowable, the method of its distribution from foreground to background can be calculated in the following way:

3.



Let EE′ be the distance between the eyes =2·5 in., QD=6 in. the nearest distance of distinct vision; CD=1 in. A small object being placed at D and another at C, the eye E sees the two objects projected in the line FG at c and D; the eye E′ sees the same objects at D and c'. Here the total displacement, adopting the picture seen by the left eye as a standard of comparison, is equal to the distance cc'. With the proportion:—

$$QC : EQ = (1{\cdot}25 \text{ in.}) :: CD : cD = \frac{cc'}{2}$$

we have at once the value of this quantity. In like manner this displacement on the line FG for 2, 3, 4 or any number of inches from Q is readily calculated.

As an example I subjoin the following table applicable to small models:

For the 19th inch above 6 inches,

		Total displacement.		
or for the 25th inch,		1·900 inch,	=	0
26	"	1·922 "	"	·022
27	"	1·940 "	"	·040
28	"	1·960 "	"	·060
29	"	1·980 "	"	·080
30	"	2·000 "	"	·100
31	"	2·016 "	"	·116
32	"	2·030 "	"	·133
33	"	2·045 "	"	·145
34	"	2·058 "	"	·158
35	"	2·072 "	"	·172
36	"	2·082 "	"	·182

* It will sometimes happen that portions of objects in the background which were hidden in the left picture are brought into view in the right hand representation. This offers no practical difficulty, for the indicated additions are readily made.

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As in using this table objects in the extreme foreground are supposed to be 25 inches distant from Q, we have for them not a displacement 1·900 in. but 0: for the 26th inch, viz. the 1st inch of depth in the picture the quantity ·022, &c. Thus if we know the distance from the spectators of the objects to be represented, they can be located on the stereograph. In the same manner tables are constructed which apply to objects placed at greater distances from the eye. Indeed after some practice very tolerable stereoscopic representations of many objects can be made without reference to such tables. (See drawing.)

This process was originally devised by me for the production of stereoscopic representations of optical phenomena, which when well executed form almost a substitute for the real illustrations. Photography for obvious reasons is not well adapted to this class of objects.

By coloring *differently*, corresponding parts of two stereoscopic pictures, or by the application of color to only one, the other being allowed to remain white or black, or by completing certain parts of the drawing only in one picture, many appearances connected with subjective optical phenomena can be represented with a degree of perfection unattainable in a single picture.

Prof. H. W. Dove, (*Farbenlehre*, p. 166) has studied the effects produced by coloring two stereoscopic drawings differently, though I am not aware that he has made this application of the results he obtained.

By slightly rotating the instrument around a line perpendicular to its axis, as was remarked to me by Prof. B. Silliman, Jr., many of these effects are greatly enhanced. The phenomena of complementary colors, and many other facts of physical optics not otherwise within the reach of most students, may also, as the same gentleman has suggested to me, be rendered intelligible by the stereoscope without the use of costly apparatus. The stereoscope is thus capable, in the hands of an expert teacher, of a far wider range of use than was at first seen.

At the suggestion of Dr. W. Gibbs, I have also made a few stereoscopic drawings of crystal models: these can be drawn by this instrument with perhaps greater facility and rapidity than any other class of objects.

The accompanying stereoscopic diagram was drawn with my apparatus without reference to tables.

Outline sketches of every description, stereoscopic drawings of ideal objects or of objects not in the possession of the draftsman, are by this process readily executed—problems evidently beyond the power of photography.

Finally the drawings thus made can be transferred to wood and stone and reproduced by the thousand.

Troy, Oct. 11th, 1860.

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ART. IX.—*Note on Sources of Error in the Employment of Picric Acid to detect the Presence of Potash;* by M. CAREY LEA, Philadelphia.

[Read before the Am. Assoc. for the Adv. of Sci., at Newport, August, 1860.]

PICRIC acid enjoys a high reputation as a test for potash. Employed in its alcoholic solution, or as soda or ammonia salt sometimes as magnesia salt, it gives with potash solutions a dense yellow crystalline precipitate. If the solution containing potash be very dilute, the precipitate may not make its appearance till after some hours repose, and it then forms long delicate needles.

Rose remarks that this reagent "is even more sensitive than the solution of chlorid of platinum." In his summing up, he observes, that of the various reagents, chlorid of platinum, tartaric acid, pictic acid, perchloric acid, sulphate of alumina and hydrofluosilicic acid, the latter is insufficient to distinguish between potash and soda; and that the chlorid of platinum and sulphate of alumina give the same reactions with ammonia as with potash.* No qualification is made with respect to the certainty of the indications afforded by picric acid. Plattner makes the same observation as to the greater sensitiveness of picric acid compared with bichlorid of platinum and equally without qualification as to its reliability.†

I therefore believe that the remarkable insolubility of otherwise soluble alcaline picrates, in alcaline solutions has not been before pointed out. If an alcoholic solution of picric acid be poured into a solution of carbonate of soda, it occasions an immediate dense yellow precipitate, not to be distinguished in appearance from a precipitate of picrate of potash, and liable to be mistaken for it with the greatest facility. The picrate of soda formed in the case just mentioned is the most soluble of all the alcaline picrates, and *à priori* we should not expect to find it precipitated under these circumstances: an aqueous solution of picrate of soda added to one of carbonate of soda acts in precisely the same manner.

To ascertain if these reactions were extended to various compounds of picric acid, examinations were made which gave with the following results:

Alcoholic solution of picric acid added to—

solution of carbonate of ammonia, gave an immediate dense yellow crystalline precipitate.

" carbonate of soda gave not so instantaneous a precipitate, but one which after standing became even more dense.

* Rose, Handbuch der Analytischen Chemie, 1r Band, 6–10 S.

† Plattner, die Probirkunst mit dem Lothrohre, 3d Ed. p. 178.

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Aqueous solutions of picrate of soda gave with
solution of carbonate ammonia, sulphate of ammonia, carbonate of soda, } abundant precipitates.
phosphate of soda, slight precipitate.

Aqueous solution of picrate of ammonia gave with
solution of carbonate of ammonia, " sulphate of ammonia, " carbonate of soda, } abundant precipitates.
" phosphate of soda, none.

Aqueous solution of picrate of magnesia gave with
solution of carbonate of soda, " carbonate of ammonia, } abundant precipitates.

When the alcaline solutions to be tested are otherwise than very dilute there is absolutely no difference in the appearance of the precipitates. When the amount of precipitate is small, the following differences may be observed:

The potash precipitate forms longer needles, and when these are found only after standing, or when the precipitate is redissolved by heat and allowed to crystallize by slow cooling, they exhibit a beautiful play of red and green colors.

The soda salt is of a lighter and brighter yellow than either the potash or ammonia salt. Its needles are also shorter than those of either of the other compounds, and when the precipitate has been redissolved by heat, and allowed to crystallize by slow cooling, they tend to agglomerate themselves together in spherical masses. This is a very marked character, and when exhibited, is unmistakable, but is not always shown.

The ammonia salt when crystallized in quantities is very distinct in appearance from the potash salt, but when thrown down in small portions, even by slow crystallization, cannot be distinguished from it with certainty. The prisms are flatter, but these differences are not apparent in very slender needles. The play of colors which the ammonia salt exhibits to a less degree than the potash, disappears entirely in the soda salt.

The above reactions indicate that extreme caution must be used in employing picric acid as a test for potash. The precipitates above described do not redissolve in any excess of the picrate, or of picric acid; nor is it to be supposed that concentrated alcaline solutions are necessary to cause them—on the contrary, in many cases, very dilute ones are sufficient. To determine within what limits such reactions are produced, the following trials were made:

A. Dilution of the alcaline solutions. Limits obtained,

(I.) With carbonate of soda,

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A solution containing 5 per cent anhydrous carbonate of soda gave
with alcoholic solution of picric acid, an immediate abundant precipitate, in 10 minutes the tube could be inverted without spilling the contents.
with solution picrate of soda, an immediate precipitate becoming in the course of an hour a very dense one.
A solution containing 2½ per cent carbonate of soda gave
with alcoholic picric acid, a slight precipitate increasing very much by standing, so that after 18 hours the tube could be inverted without spilling the contents.
with picrate of soda, none.
A solution containing 1 per cent carbonate of soda gave
with alcoholic picric acid, slight precip. after 18 hours repose.
with picrate of soda, none.
(II.) With sulphate of ammonia,
A solution containing 5 per cent anhydrous sulphate ammonia gave
with alcoh. picric acid, immediate dense precip.
" picrate soda " " "
solution containing 2½ p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.
solution containing 1 p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.
" solution picrate soda, immediate slight precipitate. The solution on standing gave a beautiful crystallization of long needles with bright play of colors, exactly resembling the reaction of potash salts.
" picrate magnesia, by long standing, a very faint precip.
" picrate ammonia, none.
solution containing $\frac{1}{250}$ anh. sulphate ammonia gave
with alcoh. picric acid, after a short interval an abundant precipitate.
solution containing $\frac{1}{500}$ anh. sulph. ammonia gave
with alcoh. picric acid, after a short interval, a considerable precip.
solution containing $\frac{1}{1000}$ anh. sulph. ammonia gave
with alcoh. picric acid, no precipitate, even after twenty-four hours' repose.

B. Limits obtained with respect to indications of diluted solutions of alcaline picrate.

A solution of picrate of ammonia in 200 parts water gave—with an equal volume of strong solution of carbonate of ammonia, an immediate precipitate of small yellow needles—in 10 minutes a considerable quantity settled at the bottom of the vessel.

A solution of same salt in 400 water gave with an equal volume of solution carbonate ammonia, signs of a precipitate in a few minutes, and after some hours an appreciable quantity settled at the bottom of the vessel.

With 1 part picrate ammonia in 800 water no precip. was produced by solution of carb. ammonia even after 24 hours' repose.

The conclusion to be drawn from these results is,

That alcoholic solution of picric acid or aqueous solution of picrate of soda will produce a precipitate in almost any alcaline

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solution, whether of soda, ammonia or potash, except under circumstances of great dilution, especially if allowed to repose for 24 hours.

That picrate of ammonia and picrate of magnesia give the same results, but in a less degree.

That picric acid is therefore wholly unreliable as a test for potash; the results obtained being such as would tend altogether to mislead those who are not extremely familiar with the appearance of the precipitates, and that in some cases the results are so deceptive that even eyes most familiar with these reactions might be deceived; for example, in the result obtained above by testing a solution containing 1 per cent. sulphate of ammonia with solution of picrate of soda. In this case a crystallization of picrate of ammonia was obtained perfectly simulating that of the potash salt.

Picric acid is in fact a better test for soda, than for potash, because with a soda solution it gives a precipitate which redissolved by heat generally (but not always) gives a characteristic spherically radiated, bright canary yellow crystallization, whereas the precipitate obtained from a potash solution can never be positively distinguished by its appearance from that afforded by an ammonia solution, and we have just seen that a solution containing $\frac{1}{200}$ of sulphate of ammonia or even less, is capable of producing such a precipitate.

Philadelphia, Feb. 23d, 1860.

ART. X.—*On a Series of New Combinations of Ammonia, Picric Acid and Metallic Bases;* by M. CAREY LEA.

[Read before the Am. Assoc. for the Advancement of Sci., at Newport, Aug. 1860.]

IN a paper published in this Journal, vol. xxvi, 379, for 1858, I described two compounds of picric acid and ammonia with copper and nickel respectively, and mentioned their instability and the great difficulty of obtaining them in a state of tolerable purity. Since then I have found that many other metals form compounds of a similar nature, and have succeeded in obtaining several of them sufficiently pure for approximate analysis. The results obtained are given below—other investigations are in progress and I hope to communicate them hereafter.

When a metallic salt is precipitated by ammonia, and a large excess of the precipitant added, a more or less complete solution of the precipitate is frequently obtained, especially if a considerable quantity of ammoniacal salt be present. I have found that these ammoniacal solutions when treated with an alcaline picrate, for the most part yield an immediate precipitate containing

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the elements of a metallic picrate united with those of ammonia. These precipitates are often very beautiful, they are generally yellow or yellowish, somewhat soluble in the mother liquid, or in strong ammoniacal solutions by aid of heat, nearly insoluble in water and decomposed by it very readily, especially if it be present in quantity, or heat be applied. Thrown on a filter and washed, the picric acid, ammonia, and some portion of undecomposed salt in solution pass through, while the greater part of the metallic oxyd remains on the filter and with sufficient washing is perfectly freed from picric acid and ammonia, and presents the appearance of a pure hydrate.

The analyses of these substances were made in the following manner. It was found desirable that before the ammonia and metallic oxyd were determined, the whole of the picric acid should first be removed. This was effected by adding chlorhydric acid to a weighed quantity of the substance carefully dried, and evaporating to dryness at a gentle heat. Ether, which must be anhydrous or nearly so, was added in the proportion of 15 to 18 grammes to ·6 or ·7 gms. of the salt used, detaching the dry crust and breaking it up to powder with a glass rod that every part might be brought thoroughly in contact with the ether. After standing ten minutes the ether was poured off, a fresh quantity added, and a larger beaker was inverted over that which contained the substance undergoing analysis. After a lapse of three or four hours the liquid was poured off, a third, and, if necessary, a fourth, quantity added in the same way. The decantation is effected with the greatest ease, as, if the ether is sufficiently strong, the chlorids remain nearly or quite dry at the bottom. It was found that by this means the picric acid could be separated with sufficient exactness to afford a tolerably correct estimation of its quantity, a careful trial with a weighed quantity of perfectly pure picric acid showed that the result fell a little under the truth by reason of a small loss arising from minute portions of the acid remaining undissolved. On the other hand, no chlorids are dissolved when the operation is properly performed: the etherial solution evaporated to dryness, and the residue dissolved in water was not troubled by solution of nitrate of silver.

The operation requires nice manipulation, otherwise the loss of picric acid is considerable, and if the ether be not sufficiently anhydrous, portions of the chlorids may be removed by it.

In this manner the quantity of picric acid was determined, and from it was calculated the quantity of the group $C_{12}H_2N_3O_{14}$, or picric acid minus the equivalent of hydrogen which is replaceable by a metallic oxyd; in other words, the group which by union with a base forms a picrate, or by union with hydrogen forms picric acid. From the residue undissolved by the ether, the ammonia was determined either by distillation with solution of caustic soda, or by precipitation with bichlorid of platinum.

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From another portion the metallic oxyd was found by appropriate means.

As far as examined, the ammonia-picrates all contain more than one equivalent of ammonia, and are represented either by the formula:—

$$2\widehat{NH_3}MO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O \text{ or } 3\widehat{NH_3}2\left[MO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O\right].$$

Ammonia-picrate of silver.

Nitrate of silver dissolved in water and treated first with excess of ammonia, and the resulting clear solution mixed with cold saturated solution of picrate of ammonia gives immediately an abundant highly crystalline light yellow precipitate of ammonia-picrate of silver, which is to be thrown upon a filter, thoroughly washed with dilute ammonia, and dried in vacuo over sulphuric acid.

It is to be observed that in the formation of this, as well as of all the other salts here described, the metallic solution must invariably be in excess to check as far as possible the precipitation of picrate of ammonia together with the compound sought. I have shown in a paper intended to be read at the same time as this,* that if an alkaline picrate be poured into an alkaline solution, a precipitate of alkaline picrate takes place. When the alcaline solution is strong the precipitate is immediate, and in the ammoniacal solutions used in the preparation of these salts any excess of alkaline picrate would fall with the ammonia-picrate. Even with every precaution, it is difficult and in some cases apparently impossible to obtain the ammonia-picrate perfectly free from this impurity.

Analysis.

·4245	substance	gave	·2632	picric acid.
·5865	"	"	·3600	" "
·4245	"	"	·1577	chlorid of silver.
·5865	"	"	·2177	" "
·3788	"	"	·4932	chloroplatinate of ammonia.

This leads to the formula:—

$$2N\widehat{H_3}AgOC_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$ - - -	61·62	61·73	61·11	61·42
Ag - - - - - -	29·19	27·96	27·94	27·95
$2NH_3$ - - - - -	9·19	9·93		9·93
	100·00	99·62		99·30

* See page 75.

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The silver falls below, and the ammonia exceeds the calculated amount in consequence of the impossibility of obtaining the salt quite free from admixed picrate of ammonia.

This beautiful salt appears to be one of the most permanent of this very unstable class of substances. It dissolves readily in hot water containing ammonia, sparingly in cold, and crystallizes in fine needles from the hot solution. Heated on platinum foil it detonates and leaves a brilliant spot of metallic silver.

Ammonia-picrate of copper.

A cold saturated solution of picrate of ammonia added to an ammoniacal solution of sulphate or nitrate of copper, immediately throws down an abundant precipitate which after washing with strong solution of carbonate of ammonia and afterward with dilute ammonia exhibits a beautiful pale greenish yellow color with a shade of red through it. It is in fine scales and much resembles the dust of the wings of butterflies.

Analysis gave for this salt a constitution similar to that of the silver salt.

·6059	gms.	substance	gave	·4652 picric acid.
·9310	"	"	"	·1279 oxyd of copper.
1·4240	"	"	"	·1577 metallic copper.
·6059	"	"	"	·2190 chlorhydrate of ammonia.

The copper was determined in the one case by precipitating the cupric solution while boiling with hyposulphite of soda, dissolving in aqua regia, evaporating to dryness, redissolving in dilute chlorhydric acid, and precipitating with distilled zinc and estimating as metallic copper—in the other by precipitating at 212° by caustic soda.

These results lead to the formula:—

$$2NH_3\overset{\frown}{CuO}.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$	77·63	76·44		76·44
Cu	10·79	10·97	11·07	11·02
$2NH_3$	11·58	11·52		11·52
	100·00			98·98

In an experiment to ascertain whether all the moisture was removed by drying in vacuo over SO_3, a quantity of about two grammes by exposure to a temperature of 210° to 212° for 9 hours in the exsiccator lost a little less than one and a half milligrammes.

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Heated on platinum foil the ammonia picrate of copper explodes with some violence and with a dazzling light.

Ammonia-picrate of Cobalt.

To a solution of protochlorid of cobalt prepared from chlorid of purpureo-cobalt in the manner recommended by Gibbs and Genth in their interesting and valuable paper on the ammonia-cobalt bases, a large excess of ammonia was added, and to the filtrate, cold saturated solution of picrate of ammonia. An abundant highly crystalline precipitate falls at once, which after drying is yellowish green: while moist decomposes with great facility with separation of cobaltous oxyd.

·6293 substance gave ·4784 picric acid.
·6075 " " ·4594 " "
·6067 " " ·1641 protosulphate of cobalt.
·5416 " " ·1475 " " "
·6075 " " ·2065 chlorhydrate of ammonia.

which results lead to the formula:—

$$2NH_3\overset{\frown}{CoO}.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O+HO.$$

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$	75·87	75·69	75·29	75·49
Co	9·82	10·13	10·29	10·21
$2NH_3$	11·32	10·81		10·81
HO	2·99			
	100·00			

This salt is much more unstable than the foregoing, and undergoes a commencement of decomposition in washing: even when this part of the operation is performed with great care, using carbonate of ammonia and dilute liquid ammonia, a portion of picrate of ammonia is washed through, and as cobaltous oxyd is not easily soluble in ammoniacal solutions, it is not easily removed by washing with such. It is also probable that more or less cobaltous oxyd is thrown down with the precipitate, as the latter at the first moment crystalline, becomes quickly more and more curdy—and ammoniacal solution of cobalt by mere dilution with water throws down a bright green precipitate. In the preparation of the ammoniacal solution, it is better to drop a strong solution of cobaltous chlorid into a large excess of ammonia.

Like the foregoing this salt explodes by heat.

Ammonia-picrate of Zinc.

To a solution of pure sulphate of zinc, chlorhydric acid was added in sufficient quantity to prevent precipitation by the sub-

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sequent addition of ammonia in excess. To the clear solution, a hot, strong solution of picrate of ammonia was added. Immediately the whole became nearly solid with beautiful yellow needles and scales—the beaker was rapidly cooled by cold water, the contents thrown on a filter, and washed first with a solution of carbonate of ammonia mixed with caustic ammonia, and finally with dilute caustic ammonia alone.

The splendid gold yellow mass of interlaced needles and scales, was more or less decomposed, even by the most careful washing, so that the brightest and purest parts only could be taken for analysis, nor were even these satisfactory.

$C_{12}H_2N_3O_{14}$	mean of 5 determinations,	81·26
NH_3	" 3 "	9·06
Zn		10·08
		100·30

The formula $3NH_3\widehat{\ }2\left[ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.\right]$ requires:—

$2C_{12}H_2N_3O_{14}$	79·692
$3NH_3$	8·913
$2Zn$	11·395
	100·00

The salt examined may be either this compound containing admixed picrate of ammonia, or may be a mixture of:—

$$2NH_3\widehat{\ }ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O, \text{ with}$$

$$NH_3\widehat{\ }ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

The fact that when a strongly acid solution of zinc-chlorid is supersaturated with ammonia, the compounds $2NH_3$ ZnO HCl and NH_3 ZnO HCl successively crystallize out, speaks in favor of the latter hypothesis.

Ammonia-picrate of Cadmium.

The cadmium salt is obtained and purified in exactly the same manner as the zinc, which it nearly resembles: it is however not so bright in color, but pure canary yellow. Like the zinc salt it redissolves in its mother liquid by heat without decomposition, but like almost all the compounds here described, when washed with pure water on a filter, the picric acid and ammonia wash through. A greyish white residue of oxyd of cadmium remains behind.

Heated on platinum foil, the salt deflagrates with a beautiful green light.

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·7170	substance gave	·5247	picric acid.	
·6622	"	" ·4877	"	"
1·1459	"	" ·8452	"	"
·6496	"	" ·1653	sal ammoniac.	
1·1459	"	" ·2945	"	"
·6045	"	" ·6289	chlorplatinate of ammonia.	
·7321	"	" ·1501	cadmium oxyd.	

These results lead to the formula:—

$$3NH_3\overset{\frown}{2}\left[Cd\,O.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.\Big]$$

	Calculated.	Found. 1.	2.	3.	Mean.
$2(C_{12}H_2N_2O_{14})$	73·67	73·44	72·86	73·31	73·20
$3NH_3$	8·24	8·10	8·17	7·93	8·07
2Cd	18·09	17·94			17·94
	100·00				99·24

It seems however not improbable that this substance may be a mixture in nearly equivalent quantities of the salts:—

$$NH_3\overset{\frown}{C}dO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O \text{ and } 2NH_3\overset{\frown}{C}dO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

for reasons similar to those mentioned in the case of the zinc salt.

Ammonia-picrate of Chromium.

This salt is easily obtained from an ammoniacal solution of chromoxyd which may be prepared in the following manner:

Three grammes of potash chrome alum are dissolved in water by boiling, the solution removed from the fire and 14 c. c. of pure concentrated sulphuric acid and 90 c. c. of liquid ammonia added. A strongly alkaline beautiful purple solution is thus obtained which may be preserved in well stopped vessels quite filled, for a considerable time.*

To a solution prepared in this manner, a strong hot solution of picrate of ammonia, not in excess, is to be added. Some precipitation follows at once which increases very much as the solution cools. The precipitate is thrown on a filter and washed with dilute liquid ammonia. It consists of splendid green metallic looking scales which if heated with a considerable quantity of water, even strongly ammoniacal, are decomposed with

* While studying the chromium salt, I met with Frémy's "Investigation of the salts of chromium." In it the author states that the salts of chromoxyd modified by boiling (green modification) are insoluble in ammonia except after having been boiled in acid and precipitated by ammonia. It will be observed that the above process is not in conformity with the opinion of M. Frémy, as it is there shown that the green modification, produced by boiling, is rendered soluble in ammonia *by the simple addition of sulphuric acid* and without any application of heat. The solution in ammonia is always complete, and the process never fails.

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precipitation of chromoxyd. On cooling, picrate of ammonia crystallizes out. Even with very careful washing the salt is always partly decomposed, with separation of green oxyd of chromium.

The portions that were least decomposed were selected, but were not sufficiently pure to give any satisfactory result, although a number of specimens were analyzed.

1.	·6949	substance gave	·5864	picric	acid.	
2.	·5537	"	"	·4735	"	"
3.	·4446	"	"	.3709	"	"
4.	·4446	"	"	·0179	sesq. ox.	chromium.
5.	·6949	"	"	·0271	"	"

These numbers correspond to

1.	$C_{12}H_2N_3O_{14}$	84·02 per cent.
2.	"	85·14 " "
3.	"	83·06 " "
4.	Cr	2·78 " "
5.	"	2·63 " "

results which do not lead to any satisfactory conclusion, but show that the quantity of ammonia salt necessary to keep the chromoxyd in solution, throws down picrate of ammonia simultaneously with the ammonia-picrate of chromium. This salt is very beautiful, its lustre is remarkable.

Ammonia-picrate of Manganese.

If ammonia be added to a solution of manganous sulphate, previously rendered strongly acid with chlorhydric or nitric acid, a considerable quantity of manganese escapes precipitation, an extremely unstable solution is obtained, which in a few minutes, even before filtration is ended, becomes cloudy again. To give the solution more stability, the presence of a very large quantity of ammonia salt is necessary, a circumstance very unfavorable for the production of a pure ammonia-picrate, as by a solution so strongly saline, picrate of ammonia (as already observed) is at once precipitated. The following were the observations made:—

A. If a cold solution of picrate of ammonia be poured into an ammoniacal solution of manganese prepared by adding to a concentrated solution of manganous sulphate an equal volume of dilute chlorhydric acid, and then ammonia in large excess, there falls a precipitate of brilliant satiny scales, mixed however with precipitated manganous oxyd, which is readily distinguishable on the filter.

B. If the ammoniacal solution is added to a hot moderately strong solution of picrate of ammonia and the whole be rapidly

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filtered, the liquid passes through before complete precipitation takes place, and on cooling, granular crystals are obtained which rapidly turn brown in the air. Heated on platinum foil, they turn brown, melt and deflagrate sharply with a brilliant white light.

Neither A, nor B, yield a salt sufficiently pure for analysis. A, always contains admixed manganous oxyd and B, picrate of ammonia. A, bears considerable resemblance to the chrome salt just described.

1·0115 of B gave ·9115 picric acid.

So large a percentage of picric acid corresponding to 89·72 per cent of the molecule $C_{12}H_2N_3O_{14}$ probably indicates a large admixture of picrate of ammonia, which cannot be removed. The formula

$$NH_3MnO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O \text{ requires } 84{\cdot}59 \text{ per cent.}$$

Ammonia-picrate of Iron.

An ammonia-picrate of protoxyd of iron appears to exist. If solution of protosulphate of iron be mixed with one of salammoniac, and then with liquid ammonia, be rapidly filtered, and the filtrate be treated with picrate of ammonia, a dark green crystalline precipitate is obtained: thrown upon a filter a red liquid passes through containing a portion of the picrate of ammonia reduced by the ferrous oxyd. The precipitate, when heated on platinum foil, deflagrates with scintillations. Heated with solution of salammoniac and caustic ammonia, it does not appear to dissolve, but ferric oxyd is thrown down and picrate and picramate of ammonia remain in solution. It was found impossible to obtain this salt in a condition to admit of even an approximate determination of its constitution.

If acetate of lead be treated with ammonia in excess, and if to the clear solution be added picrate of ammonia, a curdy precipitate, at first pale yellow, gradually deepening to orange color falls. Heated on platinum foil it detonates with violence. Boiled with caustic alkali, it disengages no ammonia. The result of an analysis showed it to be Marchand's penta-basic picrate of lead, $4PbO\ PbO\ C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O$. The above described salts containing ammonia are all highly crystalline. The lead compound just mentioned is amorphous.

Other ammonia picrates exist which I propose to examine hereafter.

Philadelphia, July 14, 1860

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ART. XI.—*The Guernsey County (Ohio) Meteorites,—a complete account of the phenomena attending their fall with a chemical analysis of them;* by J. LAWRENCE SMITH, M.D., Prof. of Chemistry in the University of Louisville, Ky.

AGREEABLY to the promise made in the July number of this Journal, I propose giving, as far as possible, a complete account of the remarkable fall of meteoric stones that occurred in the month of May in the eastern part of the State of Ohio.

I have thought proper to call them the *Guernsey County Meteorites;* since we are commonly in the habit of distinguishing the meteorites found in this country, by the name of the county in which they fell or were found. All but one of the great number of meteoric stones that fell on this occasion, were found in Guernsey county and that exceptional specimen fell in Muskingum on the edge of Guernsey county.

Although the public have been notified of this phenomenon by various observers, especially by those who gave their observations in the July number of this Journal; yet, as this paper was nearly completed at the time, and is believed to embrace a full description, it is as well to present it to the public as it is; combining all the particulars of this fall of meteorites, the most remarkable ever observed in this country, and equal to, if not surpassing the famous fall at l'Aigle in France, with which it has many points of interest in common, that will be stated in the course of this paper.

My attention was first directed to this occurrence, by a short notice of it in a newspaper, as being an earthquake that had occurred in eastern Ohio, accompanied with a shower of stones Suspecting the true nature of the phenomenon, I immediately visited the spot, where it was said to have occurred and collected the statements of those persons who had witnessed the fall. It was ascertained that on Tuesday, May 1st, 1860, remarkable phenomena transpired in the heavens, of which the following are accounts given by different observers, men of intelligence and observation.

Mr. McClenahan states that at Cambridge in Guernsey county Ohio, (lat. 40° 4′ long. 81° 35′) about twenty minutes before one o'clock, P. M., three or four distinct explosions were heard, like the firing of heavy cannon, with an interval of a second or two between each report. This was followed by sounds like the firing of musketry, in quick succession, which ended with a rumbling noise like distant thunder, except that it continued with about the same degree of intensity until it ceased. It continued two or three minutes and seemed to come from the southwest, at an elevation above the horizon of 30 to 40 degrees, terminating in the

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southeast, at about the same elevation. In the district where the meteorites fell, the explosions were heard immediately overhead.

The first reports were so heavy as to produce a tremulous motion, like heavy thunder, causing the glass in windows to rattle. The sound was so singular, that it caused some excitement and alarm, many supposing it an earthquake. At Barnesville, twenty miles east of Cambridge, the cry of fire was made, as the rumbling sound was thought to be the roaring of fire.

The day was cool and the sky covered at the time with light clouds. No thunder or lightning had been noticed that day; nor could any thing unusual be seen in the appearance of the clouds. Immediately on hearing the report, this observer looked in the direction it came, and noticed the clouds closely but could not see any thing unusual.

The next morning it was reported in Cambridge that aerolites had fallen on a farm in the vicinity of New Concord, (eight miles east, a little south of Cambridge), enquiries were immediately instituted, and Messrs. Noble and Hines state that they were near the house of a Mr. Amspoker at the time of the first explosion, which seemed directly over their heads. They looked up and saw two objects, apparently come through the clouds producing a twirling in the vapor of the cloud at the point, where they came through, then descending with great velocity and a whizzing sound to the earth—one striking about 300 yards to the southwest of them and the other about 100 yards north.

They immediately went to the spot where the first fell, and found it buried two feet in the ground. They dug it out and found it quite warm and of a sulphurous smell. The other struck a fence corner and breaking the ends of some of the rails penetrated into the earth sixteen or eighteen inches, passing through a heap of dry leaves; the first weighed 52 lbs., the other was broken up but must have weighed about 40 lbs. Another of 41 lbs. weight, not seen to fall, was discovered at the bottom of a hole two feet deep, where it had fallen on stiff turf, and was seen at the bottom of the hole, having carried the sod before it. It must have come from the southeast at an angle of 60° with the horizon. Many were discovered to have fallen southeast of Cambridge but of smaller dimensions than those already referred to. At the time of the occurrence nearly all were at dinner, or in and about their houses. The stones obtained were mostly found near houses, where they were seen to fall, as the sound of their striking the ground attracted attention.

Another well informed observer, Dr. McConnel of New Concord, (a small town eight miles east of Cambridge), furnishes the following particulars. On Tuesday, the 1st of May, at twenty-eight minutes past twelve o'clock, the people of that vicinity

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were almost panic stricken by a strange and terrible report in the heavens, which shook the houses for many miles distant. The first report was immediately overhead, and after an interval of a few seconds, was followed by similar reports, with such increasing rapidity, that after the number of twenty-two were counted, they were no longer distinct, but became continuous and died away like the roaring of distant thunder; the course of the reports being from the meridian to the southeast. In one instance, three men working in a field,—their self possession being measurably restored from the shock of the more terrible report from above,—had their attention attracted by a buzzing noise overhead and soon observed a large body descending, strike the earth at a distance of about one hundred yards. Repairing thither they found a newly made hole in the ground, from which they extracted an irregular quadrangular stone weighing fifty-one pounds. This stone had buried itself two feet beneath the surface and when obtained was quite warm.

To this we add the following statement: "We the undersigned do hereby certify; that at about half past twelve o'clock on Tuesday, May the 1st, 1860, a most terrible report was heard immediately overhead, filling the neighborhood with awe. After an interval of a few seconds a series of successive reports, the most wonderful and unearthly ever before heard by us took place, taking a direction from meridian to southeast, where the sounds died away like the roaring of distant thunder, jarring the houses for many miles distant."

Signed by A. G. Gault, Jas. McDonnald, Nancy Mills, Ichabod Grumman, Samuel Harper, Rev. Jas. C. Murch, Mrs. M. Speer, Ang'e McKinney.

The above is from those who heard the noises but did not see the fall; the following are a few statements of the many I collected from those who witnessed the fall of the stones. I extract from their depositions made at the time.

"I heard the reports and roaring as above described. And a few seconds afterwards, I saw a large body or substance descending and strike the earth four or five hundred yards from where I then stood: and that I in company with Andrew Lister, repaired to the spot and about eighteen inches beneath the surface found a stone weighing fifty pounds." Signed by Samuel Reblu.

"Heard the reports and roaring as above described: and the said Mrs. Fillis further says, that a few seconds afterwards she heard a descending buzzing noise as of a body falling to the ground. And Miss Cherry also says that she was standing near Mrs. Fillis, heard the same and saw some substance descend and strike the earth some one hundred yards distant and that Mrs. Fillis repaired to the spot and there found a stone eighteen inches

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beneath the surface weighing twenty-three pounds." Signed by Agnes Fillis, Mary J. Cherry.

"I distinctly heard the roaring and sounds as above described and a few seconds after the above report, I saw descending from the clouds a large body that struck the earth about one hundred and fifty yards from where I then stood, and I immediately repaired to the spot and about two feet beneath the surface found a stone weighing forty-two pounds, a second or two after seeing the first stone, I saw another descend and strike the earth about the same distance from where I stood, I also took the last mentioned stone from the earth about two feet beneath the surface; both the above stones when taken from the earth were quite warm. I also saw a third stone descend." Signed by Samuel M. Noble.

One observer saw a stone fall within three feet of his horse's head. One of the most southerly stones struck a barn; while some people retired within doors for fear of being struck.

These, with many others of a similar nature, were the data obtained near the region of the fall of stones. It is important to remember, that to these near observers no luminosity or fire ball was visible.

In addition to the above facts collected by ourselves, we have the following from observers at more distant points as already published by Profs. Andrews and Evans.

From the data they have collected, they consider the area over which the explosion was heard, as probably not less than one hundred and fifty miles in diameter. "At Marietta, Ohio, the sound came from a point north or a little east of north. The direction of the sound varied with the locality. An examination of all the different directions leads to the conclusion that the central point from which the sound emanated, was near the southern part of Noble county, Ohio," its course being "over the eastern end of Washington county, then across the interior of Noble county, then over the southwestern corner of Guernsey and the northeastern corner of Muskingum, with a direction of about 42° west of north."

"Mr. D. Mackley of Jackson county states that he was standing on the platform at the railroad station in Berlin, 20 miles south of Parkersburg, when he saw in a northeast direction, a ball of fire about 30° above the horizon. It was flying in a northerly direction with great velocity. It appeared as white as melted iron, and left a bright streak of fire behind it, which soon faded into a white vapor. This remained more than a minute, when it became crooked and disappeared."

Mr. Wm. C. Welles of Parkersburg, Virginia, (lat 39° 10′, long. 81° 24′,) about sixty miles south of Cambridge, saw the meteorite as a ball of fire of great brilliancy emerging from be-

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hind one cloud and disappearing behind another. Other observers at some distance to the south of the point where the fall occurred saw this meteorite as a luminous body.

The above I conceive to be all the observations worthy of note concerning the fall of this meteorite.

The time of the day, and the number and intelligence of the observers, unite to give considerable interest and value to these observations. While some of them show points of difference, natural to the observation of sudden and startling phenomena, we can yet deduce from them many conclusions with more or less accuracy, thus:—

The direction of the Meteorite.—My own observations of two of the stones which fell half a mile apart, enable me to give the direction of the meteor with some degree of exactness. The first of these stones struck the end of the rails of a Virginia (zig-zag) fence, half way down, just touching the middle rail, breaking off more and more of each rail as it passed to the ground. Connecting the points of fracture by a line, this line represents a descending curve from S.E. to N.W.

Again, the stone that fell at Law's (the most northerly), struck a large dead tree laying on the side of a hill, sloping N.W., passing through it as any projectile would; it then struck a small clump of elders, breaking them off at the root, falling finally at the foot of the hill. A line connecting these points shows the curve already stated. Coupling with this the observation of Mr. Callahan, on the direction that one of these stones penetrated the ground, with the observed path of their distribution, no doubt can remain that the general direction of their fall was from S.E. to N.W., striking the ground at an angle of about 60°.

Altitude of the Meteorite.—This is a point that can be determined but very imperfectly if at all. It may have been when first seen 40 miles above the earth, but when the explosion was heard it must have been nearer and was even still nearer when it subdivided and was scattered ('exploded' as usually termed,) over Guernsey and the edge of Muskingum counties. It is, however, but proper that I should give Prof. Evans's computation from the data he collected; they were published in the July number of this Journal, but their reproduction will not be out of place here.

"Mr. William C. Welles of Parkersburg, Virginia (lat. 39° 10′, long. 81° 24′), a gentleman of liberal education, testifies that being about three miles east of that place at the time of the occurrence, he happened to look up to the northeast of him, and saw a meteor of great size and brilliancy, emerging from behind one cloud and disappearing behind another. When about 35° east of north he thinks its altitude was 65°. Now the distance, in a direction 35° east of north, from his station to the line directly under the meteor's path, is 20 miles. Calculating from

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these data I find for the vertical height, taken to the nearest unit, 43 miles. This was at a point in Washington county near the border of Noble.

"Mr. C. Hackley testifies that he saw the meteor from Berlin in Jackson county. It crossed a cloudless space in the northeast, and he thinks its altitude, at the highest point, was 30°. Now the distance from Berlin to the nearest point under the meteor's path is 70 miles. These data give nearly 41 miles for its vertical height over Noble county, a few miles to the south of Sarahsville (lat. 39° 53′, long. 81° 40′).

"Many other reliable witnesses have been found who saw the meteor through openings in the clouds from various points west of its path; and whose testimony so far agrees with the foregoing as to give results ranging between 37 and 44 miles. Care has been taken as far as possible to verify the data in each case by personal examintion of the witnesses. The angles have in most instances been taken as pointed out by them from their respective posts of observation. It is unfortunate that no case has come to our knowledge in which the meteor was seen from the region east of its path. But it was a circumstance in some respects favorable to the definiteness of the observations made from the west side, that the observers in nearly all cases saw the meteor only at one point, or within a very small space on the heavens. It is impossible to reconcile the various accounts without granting that its path was very nearly as above described, and that its height did not vary far from 40 miles as it crossed Noble county.

"In regard to the time which intervened, at different places, between seeing the fire-ball and hearing the report, the statements are so vague that not much reliance has been placed upon them. It may be remarked, however, that they will essentially agree with the foregoing conclusions, if we suppose that the loudest explosion took place in the southern part of Noble county.

"I will add under this head the statement of Mr. Joel Richardson, of Warren, Washington county, who from a place six miles west of Marietta, saw the meteor as much as 15° or 20° west of north, at an altitude of about 45°. The direction in this case was so oblique to the meteor's path, that the data are of little value for simply determining the height; but they are important on account of their connection with the place of the meteor's last appearance. Mr. Richardson was visited by the writer, and his testimony was subjected to close scrutiny. If we take the azimuth at 15° west of north, we shall have a distance of 41 miles to the line under the meteor's path; and these data will give about 41 miles for its vertical height over a point not more than a mile from New Concord, at the extreme western limit of the district along which the meteorites were scattered. If we take the azimuth at 20° west of north, both the distance and the

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height will be greatly augmented. I have found two persons living near Bear Creek, nine miles north of Marietta, who make statements closely corroborating that of Mr. Richardson.

"D. Mackley, Esq., a lawyer of Jackson, Ohio, who at the time of the occurrence happened to be at Berlin, about six miles northeast from the former place, and seventy miles from the nearest point under the meteor's path. He took pains to note all the facts as accurately as he could at that time; and he afterwards returned to the spot in order to determine more definitely the points of the compass. His testimony, in answer to my interrogatories is substantially as follows:—

"The meteor first appeared to me at a point about 55° east of north. It moved northward in a line very nearly parallel with the horizon. When it disappeared it had described an arc of about 15°. It was in sight about 6 seconds. Its altitude was about 30°. In regard to its size, I have since looked at the sun through a thin cloud, and I think the apparent diameter of the meteor was one-half that of the sun."

"These data give the meteor a height of 41 miles over the northern boundary of Noble county; a diameter of three-eighths of a mile; and a relative velocity of nearly four miles a second. The results agree sufficiently well with those before given."

Temperature of the Stones.—Several of the largest stones were picked up ten minutes after their fall, and are described as being about as warm as a stone that had lain in the sun in summer. One fell among dry leaves that covered it after it had penetrated the ground; the leaves, however, showed no evidence of having been heated; no appearance of ignition was discovered in places or objects with which the stones came in contact at the time of their fall, so that their temperature must have fallen far short of redness, while it may not have reached that of 200°.

Size and Velocity.—I have no data upon which to calculate either of these. Prof. Evans, however, as just quoted, calculates from the data above given, that its size was $\frac{3}{8}$ of a mile and velocity four miles a second.

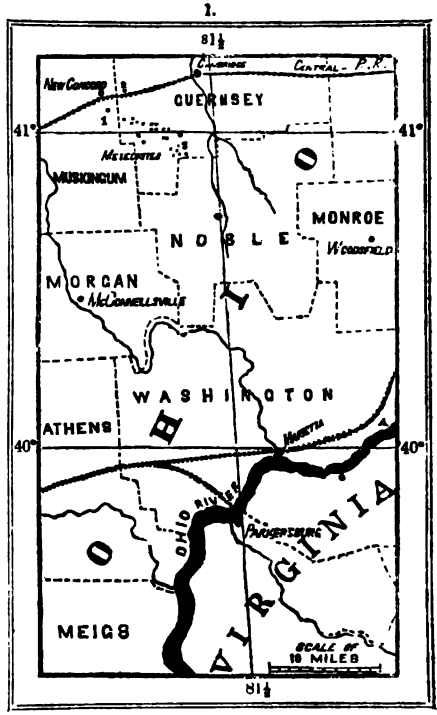
While I may furnish no more reliable computations from the data obtained, I may be excused a short criticism on the above results to prevent too hasty conclusions being formed.

As regards the supposed elevation of forty miles *when the first reports were heard*, I would simply ask the question, is it possible, with the established views of the conduction of sound by rarefied air that any conceivable noise produced by a meteorite forty miles distant from the earth, in a medium quite as rare if not rarer than the best air pump can produce, would reach us at all, or if so, in the manner described by observers? This question is a more important one to consider, as some observers on similar data have calculated the elevation of meteorites, where they were first heard to explode, at one hundred miles.

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As regards the size of the meteorite, I have but to refer the reader to my experiments made in 1854, and published in this Journal in 1855,* to show the perfect fallacy of calculating the size of luminous objects by their apparent disks, and I shall have more to say on the same subject in a future paper. It is important to note that the nearest approach of the meteor to the earth must have been in the northern part of Noble and in Guernsey counties, the point from which its most wonderful display seemed to have manifested itself, yet we hear nothing of its future career by reports from observers north of this, while its approach from the south to this point was noticed by a number of observers.

I need hardly state my own convictions are, that the meteorite terminated its career in Guernsey county, and that the group of stones which constituted it were scattered broad cast over that county: many have been collected, and many lie buried in the soil to moulder and mingle their elements with those of this earth.



We come now to consider the stones that fell and were collected. Their number was over thirty, and their places of falling have been plotted with some care in the accompanying map.

The localities of twenty-four have been fixed with precision, by the assistance of the Hon. C. J. Albright; but from the diminished scale of the map, it is impossible to place a number by each dot intended to represent the locality of a meteoric stone. No. 1 on the map is the spot where the largest stone was found, weighing 103 lbs. No. 2 is the next largest, weighing 56 lbs., and No. 3, the smallest, weighing 8 oz. The largest were at the northwest extremity, and smallest, at the southeast, the space over which they were scattered, was about ten miles long by three miles broad.

* Vol. xix, 340.

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The following is a catalogue of 24:

No.	Weight.	Fell on farm of
1	103 lbs.	Shenholt.
2	56 "	Law.
3	52 "	Amspoker.
4	50 "	Amspoker.
5	41 "	Torrence.
6	36 "	Reasoner.
7	23½ "	Hodges.
8	26 "	Fillis.
9	16 "	Adair.
10	15 "	Craig.
11	8¼ "	Craig.
12	4½ "	Waller.
13	4 "	Beresford.
14	3¾ "	Craig.
15	3¾ "	Stevens.
16	3¾ "	Wall.
17	3 "	Walker.
18	2¾ "	Claysville.
19	2 "	Stevens.
20	2 "	Wall.
21	2 "	Savely.
22	1 "	Carter.
23	1 "	Heskett.
24	½ "	Heskett.

Others have been found but I have no correct record of their exact position.

Some fifteen of these stones have come under my observation; they are all irregular in shape, cuboidal, wedge-shaped, globular and every conceivable form that irregular fragments of stone may be supposed to possess; they all have the well-known black coating with a sharp outline between the coating and grey mass of the stone, and there is quite a uniformity in the character of the coating in both small and large stones.

When broken this meteor exhibits a grey mass, with metallic particles of nickeliferous iron,* resembling the stones I examined that fell in Harrison county, Indiana, on the 28th of March, 1859, the latter however is the coarser grained of the two. Prof. Shepard who is familiar with the meteoric stones preserved in the cabinets of this country and in Europe, says: "In its internal aspect it approaches the stone of Iekaterinoslaw, Russia, (1825), though it is somewhat finer and more compact. In crust the two are identical. It is also similar to the stone Slobodka, Russia, (Aug. 10th, 1818); and compares closely with those of Politz, (Oct. 13th, 1819), of Nanjemoy, Maryland, (Feb. 10th, 1828),

* I have picked out pieces of the iron weighing two grains, closely cemented to pyrites.

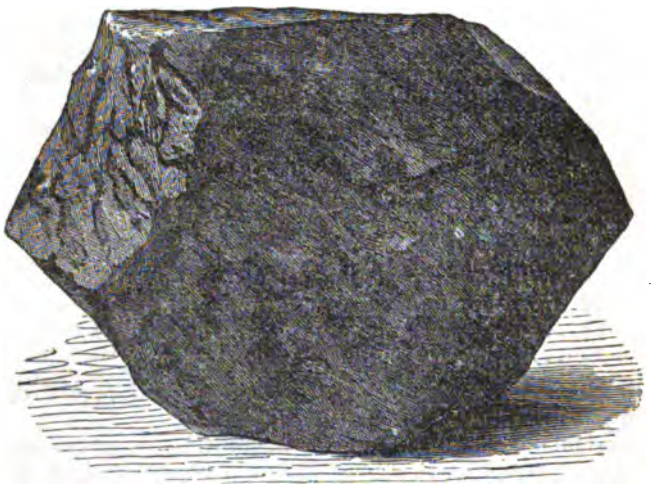
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and of Kuleschowka, Russia, (March 12th, 1811), but the crust is less smooth on the Ohio stone than in that of the latter. In fact its character is, that of a large portion of the known meteoric stones."

The general thickness of the crust is about from $\frac{1}{50}$ to $\frac{1}{10}$ of an inch.

The following is the figure of the largest stone that has been found, now in the cabinet of Marietta College, and described by Prof. E. B. Andrews, (this Jour., July, 1860, page 104). We reproduce the figure from Prof. Andrews's article here cited.

2.



Several specimens have been examined, they all show the presence of the same minerals with a slight variation in their proportions as might be expected in a mass not homogeneous. Its composition is fairly represented as follows:—Specific gravity, 3·550, varying slightly in different specimens.*

In 100 parts, there are,—

Nickeliferous iron,	10·7
Earthy minerals,	89·3

The nickeliferous particles separated by a magnet from the crushed stone and well washed, presented the following constituents in 100 parts.

Iron,	87·011
Nickel,	12·360
Cobalt,	·421
Copper,	minute quantity not estimated.
Phosphorus,	·012
Sulphur,	1·080

* Mr. Johnson gives it as 3·5417, this Journal, [2], xxx, 111.

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The sulphur comes from magnetic pyrites that the meteorite contains and that it is not easy to separate mechanically from the small particles of nickeliferous iron.

The earthy part when freed as thbroughly as possible from nickeliferous iron (which can be done pretty effectually by the magnet), was treated with warm dilute muriatic acid, thrown on a filter first washed thoroughly with water, then with a solution of potash to dissolve the last portion of the silica of the decomposed portion of the mineral. The result was in 100 parts:

Soluble portion,	63·7
Insoluble "	36·3

The earthy material analyzed as a whole was found to contain,

Silica,	47·30
Oxyd of iron,	28·03
Alumina,	0·31
Magnesia,	24·53
Lime,	·02
Soda, Potash,	1·04
Manganese,	*trace.*

From these results it is very clear that the mineralogical constitution of these meteoric stones is about as follows in 100 parts.

Nickeliferous iron,	10·690
Schreibersite,	·005
Magnetic pyrites,	·005
Olivine,	56·884
Pyroxene,	32·416

This sums up the history of this meteoric shower, with as full an account as possible of the stones that fell at that time. In the first part of this paper it was stated that this fall was quite as remarkable as that near L'Aigle in France in 1803. Although it does not equal this latter in the number of stones that were collected, it exceeds it in the size of the stones that fell. The largest of the L'Aigle stones weighed 17½ lbs., while the largest in the present case was 103 lbs.

There are many points of coincidence in the phenomena and circumstances attending the two falls. Were I to copy Biot's description of the phenomena of the fall at L'Aigle as detailed to the Academy of Sciences nearly sixty years ago, it would be but a repetition of what has been written in the first part of this paper.

The date of fall at L'Aigle was the 26th of April, the date of the Guernsey fall, May 1st; time of the day of the former, one o'clock, of the latter, twenty minutes of one. The direction of both falls from southeast to northwest. The extent of surface covered by the first seven and a half miles wide by two and a

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half broad, by the latter, ten miles long by three wide. And both were seen by a large number of persons.

Since my memoir on meteorites was presented to the American Association for the Advancement of Science, and published, I have collected several important physical and chemical data that cannot be overlooked in the study of the nature and origin of these bodies. I will merely enumerate some of them now; reserving for a future occasion the proof upon which they are based and the deductions that may be drawn from them. 1st. The light emitted from meteoric stones does not arise from incandescence, but from electricity or some other cause. 2nd. That the noise attending their fall is not that arising from the explosion of a solid, but that it is by concussion of the atmosphere arising from the rapid motion of the body through it or in part due to electric discharge.

3d. That meteoric showers are not the results of fragments from the rupture of one solid body, but the separation of small and distinct aerolites that have entered our atmosphere in groups. 4th. That the black coating is not of atmospheric origin, but is already formed when these bodies enter our atmosphere.

I would also call the attention of those engaged in the examination of this class of bodies to the study of the true nature of their black coating, also to the fact that observers at a distance often see these bodies in a luminous state, while those situated where they fall, do not observe this luminosity.

ART. XII.—*Abstract of a Discussion of the Influence of the Moon on the Declination of the Magnetic Needle, from the observations at the Girard College, Philadelphia, between the years* 1840 *and* 1845; by A. D. BACHE, Superintendent United States Coast Survey.

THE existence of a sensible lunar effect on the magnetic declination has already been established by the labors of Brown, Kreil, Sabine and others. It is nevertheless important to add the weight of new numerical results to those already obtained.

In the discussion of the Philadelphia observations of magnetic declination already presented to the Association, I have shown how the influence of magnetic disturbances, of the eleven year period, of the solar diurnal variation and its annual inequality, of the secular change, and of the annual variation may be severally eliminated, leaving residuals from which the lunar influence is to be studied.

Each observation was marked with its corresponding lunar hour and the hourly normals used for comparison. This method

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of treatment of the subject is that followed by General Sabine in his discussion of the results of the British observations. The details of the method will be better understood by an example.

The time of the moon's passage over the meridian of Philadelphia (upper transit) was obtained from the American Almanac, the small correction for the difference of longitude being neglected. The observation nearest to the local mean solar time of the moon's transit was marked with a zero, signifying 0^h of lunar time. The time of the inferior transit was next obtained, and the observation nearest to it in time was marked 12^h. The greatest difference in interval between the moon's transit and the time of observation could in no instance exceed half an hour. In the bi-hourly series the observations nearest the moon's transit, or to either hour angle, one hour before or one hour after the transit was marked. The mean of a number of differences for the same hours will thus give a result corresponding sufficiently near to the hour. The number of observations intermediate between those marked 0^h and 12^h were marked with the corresponding hour angle by interpolation, care being taken to note the nearest full hour against each observation in the bi-hourly series. The hourly series begins with October, 1843. In the case of thirteen observations within twelve lunar hours, the one nearest midway between the two consecutive lunar hours was omitted.

The month of March, 1842, is selected as an example of working the bi-hourly series, and the tables are given in the complete paper which, it is expected, will be published in the Smithsonian Contributions to Knowledge.

One of the first questions to be determined is, how many of these residuals must be used to give a definite result, another one is, whether numbers deduced from different parts of the series would give harmonious results. To test both of these the observations were formed into three groups, one containing 4900 in 19 months of 1840 and '41; another 6715 results in 21 months of 1842 and '43; and a third 10029 results in 18 months of 1844 and '45; in all 21644 results.

The tables for the several months and for each year, showing the residuals for each lunar hour, are given in the complete memoir in detail, as also the results of the discussion of groups I and II, and of III, in which all the observations are united. Special investigation showed that the weights were nearly proportional to the number of observations, a result which indicates that no undue constant errors influence the result.

The results of the discussions of these three groups were also expressed by Bessel's formula and treated by the method of least squares. Two terms of the formula suffice to represent the observations, and there is no constant term, indicating that

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the moon has no specific constant action of deflection on the needle. The coefficient of the first term is small, the character of the curve depending chiefly upon the second term which produces a double crested curve showing two eastern and two western deflections in one lunar day. The difference in the amount of the eastern and of the western ranges depends upon the coefficient of the first term. The progression of the hourly values is systematic, and the agreement between the computed and observed values is satisfactory. On the Diagram B, the observed values are indicated by dots and the smooth curve results from the equation.

The difference between the curves of deflection for the eastern and western hour angles shown in the curve, enables us to determine the diurnal lunar tide and is drawn on the plate and represented by the first term of the formula. The interference of the two curves gives the observed form.

The curves all agree in their distinctive characters, and show two east and two west deflections in a lunar day, the maxima W. and E. occurring about the upper and lower culminations and the minima at the intermediate six hours. The total range hardly reaches 0″·5. These results agree generally with those obtained for Toronto and Prague. From 8000 to 10000 observations seem to be required to bring out the results satisfactorily, and the best results are derived from the use of both groups. The principal western maximum occurs six minutes after the lower culmination of the moon and amounts to 0″·23. The secondary maximum occurs fourteen minutes after the upper culmination and amounts to 0″·18. The principal maximum occurs at $6^h\ 17^m$ after the lower culmination, the easterly deflection being 0″·22. The secondary maximum at $6^h\ 03^m$ after the upper culmination has a deflection of 0″·19. The greatest range is 27″ and the secondary 22″. The epochs of the maxima and minima are found from the formulæ to be at a mean, ten minutes after culmination. The probable error of a single computed value of the lunar diurnal variation is ±1″·32. The Toronto observations gave ±1″·37 from more than twice the number of observations, so that the Philadelphia observations appear to be worthy of every confidence. At Toronto from the second investigation, embracing about 44,000 observations, the western and eastern deflections balanced, giving for the range 38″·3. The Prague observations also confirm the nearly equal deflections (mean) to the west and east. The epochs of the maxima and minima were found from the four roots of the equation $0 = 0{\cdot}029 \cos(\theta + 295°) + 0{\cdot}414 \cos(2\theta + 85°)$ which gave ten minutes as the mean time elapsed between the moon's passing the meridian and the time of maxima of deflection. If we take the four phases into account the lunar action seems to be retarded ten minutes, which may be termed the *lunar*

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magnetic interval for the Philadelphia station. At Toronto the intervals are not so regular. The secondary range exists there, and is also a marked feature in the Prague results.

The lunar diurnal variation seems to be the subject of an inequality depending on the solar year, for the investigation of which the preceding results were rearranged in two groups, one containing the hourly values for the summer months (April to September), the other the values for the winter months (October to March). For the summer season we have 11087 observations, and for the winter 10557.

In the complete memoir the tables of the hourly sums of the lunar variations for the summer and winter seasons are given, and the tabular results are expressed analytically. The curves representing them are shown in the annexed Diagram C.

The characteristic feature of the annual inequality in the lunar diurnal variation is, therefore, a much smaller amplitude in winter than in summer. Kreil indeed inferred from the ten year series of the Prague observations that in winter the lunar diurnal variation either disappears or is entirely concealed by irregular fluctuations, requiring a long series for their elimination. The method of reduction which he employed was however less perfect than that now used. The second characteristic of the irregularity consists in the earlier occurrence of the maxima and minima in winter than in summer. The winter curve precedes the summer curve by about one and three quarter hours. Both these features are well expressed in the diagram C. At Toronto the same shifting in the maxima and minima epochs was noticed, but the other irregularity in the amount of deflection is not exhibited. It seems probable that the Philadelphia results are more typical in form than those either of Prague or Toronto.

It is also apparent that the smaller deflection at the upper culmination in the annual mean, when compared with the deflection at the lower culmination, is entirely produced by the feeble lunar action in winter. The maximum west deflection in summer occurs actually near the upper culmination. At the same season the maximum east deflection is still retained (as in the annual curve) about six hours after the lower culmination. In the winter season this last mentioned maximum east deflection is actually the smaller of the two. We have

Maximum summer range,	- - -	35″·4, secondary	31″·8
" winter "	- - - -	25 ·2, "	15 ·6
difference,	- - - -	10 ·2,	16 ·2

At Prague the maximum summer range was 44″.

I next proceed to examine whether the phases, declination or parallax of the moon, have any sensible effect upon the magnetic declination. Dr. Kreil found from a ten years series

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of observations at Prague, that there was no specific change in the position of the magnet depending upon the moon's phases and parallax, but that the declination was 6″·8 greater when the moon was at the greatest northern declination than when at the greatest southern declination. On the contrary Mr. Brown from the Makerstoun observations, a much shorter series than the one at Prague, inferred that there was a maximum of declination two days after the full moon. He also found a maximum corresponding to the greatest northern declination of the moon, but does not appear to have investigated the effect of distance.

The residuals which we have been treating enable us at once to examine these several points.

Beginning with the lunar phases, the daily means for the day of full and new moon, and for two succeeding days, were compared with the monthly mean declination. In case any of the hours were disturbed, the monthly normal for the hour was substituted for the disturbed observation before the mean was taken. If one half or more of the hourly readings were disturbed, the daily mean was altogether omitted. Accidental omissions of hourly observations were supplied by the hourly normal. The half monthly normals were then compared with the half monthly means. In the table of differences thus formed equal weight is given to the bi-hourly and hourly observations. The daily mean having been subtracted from the monthly mean, the positive sign indicates a western deflection and the negative sign an eastern one, as compared with the normal position. The following table contains the results:

	Sum of deflections.	Number.	Deflection.		
			d.		
Full moon,	+11·6	52	+0·22	+0′·10	±0′·07
1st day after,	− 7·1	51	−0·14	−0 ·06	
2d day after,	− 9·3	48	−0·19	−0 ·08	
New moon,	−11·5	43	−0·27	−0 ·12	±0′·09
1st day after,	+ 1·5	47	+0·03	+0 ·01	
2d day after,	+ 4·4	49	+0·09	+0 ·04	

The effect is very small, scarcely much beyond the probable error; but the table indicates that the north end of the magnet is deflected to the westward 0′·1 at the full and as much to the eastward at the day of new moon, the range between full and new moon being 0′·2. A more definite result could hardly be expected from a series of observations extending over but five years.

Treating the effect of the moon's variation in declination in precisely the same manner we obtain the following results:

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Mean deflection.			
One day before,	−0′·20	from 54 days of observation.	
At moon's max. declin.,	−0′·10	" 53	"
One day after,	−0 ·09	" 55	"
Mean,	−0 ·13	" 162	"
One day before,	−0 ·04	" 54	"
At moon's min. declin.,	−0′·07	" 52	"
One day after,	+0 ·14	" 52	"
Mean,	+0 ·01	" 158	"

The results do not positively prove a deflection of the magnet depending on the moon's greatest north and south declination. The amount resulting from the comparisons being of nearly the same magnitude as its probable error.

A similar investigation with respect to the moon's distance from the earth gives the following results.

Mean deflection.			
One day before,	−0′·18	from 50 days of observation.	
At moon's perigee,	−0 ·18	" 41	"
One day after,	−0 ·00	" 59	"
Mean,	−0 ·12	150	
One day before,	−0′·02	" 55	"
At moon's apogee,	−0 ·20	" 53	"
One day after,	−0 ·13	" 47	"
Mean,	−0 ·12	" 155	"

The difference being of the same order of magnitude as the probable errors, no conclusion as to the effect of distance can be drawn from them.

I propose hereafter to extend the discussion of the moon's effect on the declination to the effect on the earth's magnetic force.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Chemical Analysis of the Solar Atmosphere.*—KIRCHHOFF has communicated some further results of his remarkable investigations on the constitution of the solar atmosphere, a notice of which has already been given in this Journal. The author maintains that the sun has an ignited gaseous atmosphere which encloses a core of still higher temperature. If we could see the spectrum of this atmosphere, we should detect the bright lines which are characteristic of the metals existing in it, and should recognize the metals themselves from these. The more strongly luminous body of the sun does not however permit the spectrum of his atmosphere to appear. It inverts this spectrum so that instead of the

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bright lines which the spectrum of the atmosphere alone would exhibit, dark ones make their appearance. We see therefore, only the negative image of the spectrum of the sun's atmosphere.

In order to study the solar spectrum with the requisite degree of accuracy, Kirchhoff procured from the workshop of Steinheil an apparatus consisting essentially of four large flint glass prisms and two telescopes.

With this apparatus the spectra are seen in a hitherto unattainable degree of distinctness and purity. It exhibits in the solar spectrum thousands of lines with such clearness that they are easily distinguished from each other. It is the author's intention to draw the whole spectrum as seen with his apparatus, and he has already done this for the portion which lies between Fraunhofer's lines D and F.

This apparatus exhibits the spectrum of an artificial source of light with the same distinctness as the solar spectrum, provided only that the intensity of the light is sufficient. A common gas flame in which a metallic compound evaporates, is usually not sufficiently luminous but an electric spark gives with the greatest distinctness the spectrum of the metal of which the electrodes consist. A large Ruhmkorff's induction coil yields electric sparks in such rapid succession that the spectrum can be observed as easily as that of the sun.

A very simple arrangement permits the comparison of the spectra of two sources of light. The rays of one of the sources may pass through the upper half of the vertical slit, while those of another pass through the lower half. When this is the case, one of the two spectra is seen immediately beneath the other, and it is easy to determine whether coincident lines occur in both.

In this manner the author satisfied himself that all the bright lines peculiar to iron correspond to dark lines in the solar spectrum. In the portion of the spectrum between D and F, about 70 particularly well-marked lines occur, resulting from the iron in the sun's atmosphere.

Iron is remarkable on account of the great number of distinct lines which it produces in the solar spectrum; magnesium is interesting because it produces the group of Fraunhofer's lines lying in the green denoted by Fraunhofer by *b*, and consisting of three very strong lines. Very distinct dark lines in the solar spectrum correspond to the bright lines produced by chromium and nickel, and we may therefore regard the presence of these substances in the sun's atmosphere as proved. Many other metals appear however to be wanting in the sun's atmosphere. Silver, copper, zinc, lead, aluminum, cobalt and antimony have extremely brilliant lines in their spectra; but no distinct dark lines in the solar spectrum correspond to these.

Many metallic compounds do not give in a gas flame the spectrum of their metal, because they are not sufficiently volatile: in these cases the spectrum may be made to appear by means of the electric spark. It is true that in this case the spectrum of the metal of which the electrodes consist and that of the air in which the spark passes is also seen. To avoid the difficulty arising from the very great number of bright lines of which the spectrum of every electric spark consists, it is necessary to have recourse to a particular arrangement. The electric spark is allowed to pass at the same time between two similar pairs of elec-

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tro'es, the light of one spark being allowed to pass through the upper, that of the other through the lower half of the slit, so that one spectrum is seen above the other. When the two pairs of electrodes are clean, the two spectra are perfectly similar: when however a metallic compound is placed upon one pair, the corresponding spectrum immediately shows the lines belonging to the metal introduced. The author has satisfied himself that in this manner even the metals of the rare earths, yttrium, erbium, terbium, etc., may be recognized most quickly and certainly. It is therefore to be expected that by the help of Ruhmkorff's apparatus, the spectral method of analysis may be extended to the detection of all metals. The researches which the author has undertaken in connection with Bunsen will, it is hoped, determine this point.—*Journal für prakt. Chemie, No.* 16, 1860.

2. *On a New Alkaline Metal.*—Bunsen has discovered in the waters of several mineral springs, a new alkaline metal, the existence of which was first detected by the spectral method of qualitative analysis, already noticed in this Journal. The new alkali exists in these waters together with potassium, sodium, and lithium, and its presence may be shown by the spectral analysis with the greatest facility, although only a few milligrammes are contained in several kilogrammes of the material. The author gives only a very brief preliminary notice of the new metal, promising a more extended investigation. The chlorid may be distinguished from the chlorids of sodium and lithium by the yellow precipitate which it gives with chlorid of platinum. It is distinguished from potassium by the solubility of its nitrate in alcohol. The vapors of the compounds of this metal, when heated so as to become luminous, give an extremely characteristic spectrum, which at the same time exhibits the remarkable simplicity of the spectra of the other alkaline metals. Its spectrum consists of only two blue lines—a weaker line, corresponding with the blue strontium line and another which lies only a little farther toward the blue end of the spectrum, and which vies in intensity and sharpness of definition, with the red line of lithium.—*Journal für prakt. Chemie*, 16, 1860.

3. *On the colors of Flames.*—Merz has communicated some investigations on the coloration of the flames of Bunsen's burner and of hydrogen gas produced by the presence of various substances. These observations may be considered as supplementary to those of Bunsen already noticed in this Journal, and although less certain, are simpler and more easily applied than the processes of the spectral analysis. The author employs a flame of pure hydrogen as well as that of Bunsen's burner, and in addition, makes use of blue, violet, red and green glasses. The new substances which he describes as giving characteristic colors to the flame of Bunsen's burner, are nitric, chromic and molybdic acids, while phosphoric and sulphuric acids give a peculiar coloration to the dark core of the flame of hydrogen.

The flame of Bunsen's burner gives three sorts of colors—*a*. Border colors. These are of course peculiar only to the most volatile substances. To produce them, the loop of platinum wire is to be held outside of the flame about one or two millimeters from the lower portion of the outer limit *b*. Mantle colors—those namely which are seen when the substance

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is held in the bright blue colored mantle which forms the outer portion of the flame. *c.* Flame colors. To produce these, the loop is to be held horizontally and in the hottest part of the mantle. The hydrogen flame yields another species of color—viz, the core colors. These are produced only by sulphuric and phosphoric acids, which communicate respectively a blue and green tinge to the cold core of the hydrogen flame.

Nitric and nitrous acids give a bronze green border color, usually with an orange colored border. The test is to be previously dried in the flame, and dipped into a solution of bi-sulphate of potash, or into dilute muriatic acid, according as we wish to test for nitric or nitrous acid. The sensibility is about $\frac{1}{40}$ mgrm. Compounds of ammonia and cyanogen give the same bronze green border, but more faintly.

Phosphoric acid gives a grey-yellow-green border color, as well as a beautiful green core color. The dry test is to be dipped into sulphuric acid and held in the flame in the manner above pointed out, in order to show the border color. The sensitiveness is $\frac{1}{8000}$ mgrm. The green core color is less sensitive, but indispensable in recognizing phosphoric acid in the presence of large quantities of boric acid, and is produced by alternately moistening the test with a solution of fluosilicic acid, and holding it till ignition in the hydrogen flame, until the color distinctly appears.

Sulphuric acid produces a beautiful blue core color, being reduced to sulphurous acid. Free sulphuric acid gives the color when the platinum loop is held in the border of the flame, but a sulphate must be held in the middle of the flame. In the latter case, it is well to dip the test into strong muriatic or fluo-silicic acid. The sensibility for sulphuric acid is $\frac{1}{4000}$ mgrm., for a sulphate, $\frac{1}{1000}$ mgrm.

Boric acid gives a beautiful green mantle color, which is so intense that the acid may be recognized in the presence of large quantities of phosphoric acid. The sensibility $\frac{1}{1400}$ mgrm. Borates are to be decomposed with sulphuric acid.

Chromic acid gives a dark brownish red border color, and a rose red mantle color. The sensibility is $\frac{1}{1000}$ mgrm. The dry test is to be moistened with concentrated sulphuric acid, and held in the border. Oxyd of chromium gives no color, and is to be first oxydized to chromic acid by moistening with a solution of hypochlorite of soda, and drying. Molybdic acid gives a yellowish green flame-color like that of baryta, which is however very fleeting, and only occurs on moistening the test with muriatic acid.

Muriatic acid gives a very weak greenish blue border-color, which lasts for a very short time, and therefore does not deserve attention. The acid is however decomposed into free chlorine which may easily be recognized.

Potash gives a grey blue mantle-color and a rose violet flame color. These colors appear reddish violet through the blue glass, violet through a violet glass, and blue green through a green glass. Potash is recognized in the presence of lithia, as well as through so thick a layer of blue glass that the lithium red is no longer visible. The test is to be moistened with sulphuric acid, and repeatedly exposed to the flame for a short time. The sensibility is $\frac{1}{31000}$ mgrm., for blue, $\frac{1}{15000}$ mgrm. for green glass.

Soda gives an orange yellow flame-color, which in very large quantities appears pure blue, but in small quantities is invisible through the blue

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glass; through the green glass, the soda flame appears orange yellow, even with the smallest quantities. This glass is particularly adapted to the recognition of soda in all its compounds. The sensibility is $\frac{1}{780.000}$ mgrm. The test is to be moistened with sulphuric acid; dried and held in the hottest point of the flame.

Lithia gives a carmine red flame-color which appears violet red through the blue, carmine red through the violet but is invisible through the green glass. The test is to be moistened with sulphuric acid and treated like potash, the sensibility is $\frac{1}{140.000}$ mgrm. In the presence of soda, lithia is recognized through the blue glass; in the presence of potash, by the method given by Bunsen. In the case of the alkaline earths, the test is to be moistened with sulphuric acid, carefully dried, and held in the hottest point of the mantle. After all the alkalies have evaporated, the earths may be detected.

Baryta may be recognized by the yellowish green flame-color which appears blue green through the green glass. The sensibility for baryta alone is $\frac{1}{85.000}$ mgrm. If the green disappears and a red flame-color makes its appearance, the test is to be repeatedly moistened with muriatic acid, and immediately introduced while wet into the hottest part of the flame. If the blue green color is no longer seen, we proceed to examine for lime.

Lime is present when the red flame-color, on evaporating the last portion of muriatic acid, appears siskin green through the green glass. Strontia gives in this case a weak yellow. The sensibility of lime alone is $\frac{1}{70.000}$ mgrm., but by employing the green glass, $\frac{1}{18.000}$ mgrm.

Strontia may be recognized by the purple or rose color which is seen through the blue glass when the test, after moistening with muriatic acid, is evaporated to dryness in the flame.

Copper as chlorid gives an azure blue zone, and as nitrate, a pure green flame-color. By the combined observation of both colors, copper may be distinguished from all other metals which give similar colors. The sensibility of copper alone is $\frac{1}{3.000}$ mgrm. The other flame-coloring metals, such as arsenic, antimony, tin, lead, mercury and zinc, exhibit especially in the form of chlorids, more or less intense bluish or greenish mantle-colors, which however cannot be advantageously used as reactions for the metals themselves.—*Journal für prakt. Chemie*, No. 16, 1860.

4. *The Dichroscope.*—The apparatus to which Prof. Dove has given this name is intended for the following purposes:—

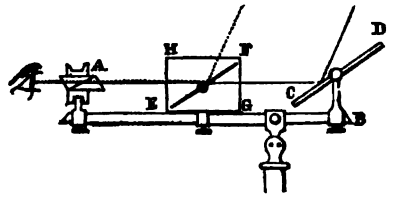
(1.) To represent interferences, and spectra in different-colored light, both separately and combined.

(2.) To imitate the phenomena of dichroism, both in the case in which dichroitic crystals are viewed through Haidinger's rhomb of calc spar, and also in the case of the phenomena produced when the dichroitic crystals themselves are used as analyzers in a polariscope.

(3.) To combine elliptically, circularly, and rectilinearly polarized and unpolarized light, not in such a manner that the one is produced by the polarizing, and the other by the analyzing arrangement, but so that they traverse the doubly refracting media simultaneously, and are then submitted to any analyzing arrangement.

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HEGF is the dichroscope which is placed in a polariscope as indicated in the figure; A, being the Nicol's prism, and CD the polarizing mirror.



It is a brass box 81 millim. long, 75 high, and 70 broad, three sides of which are open; these sides, HE, HF, FG, can be closed by opaque slides, or by plates of colored glass; a single glass plate, or sets of glass plates, can also be inserted in the direction EF, as seen in the figure. The side HE, is destined to receive cooled glasses, crystals, or a rotating circular-polarizing plate of mica. The side HE, can be closed by a slide having in it a slit for prismatic analysis or a circular aperture for experiments, with fine gratings. Two mirrors belong to the apparatus: one is silvered, the other blackened.

It being assumed that the linear analyzing arrangement is so placed that in a crystal of calc spar cut at right angles to its axis and placed between A and HE, the rings and black cross are visible, the following combinations may be obtained.

1st. Employing CD the silvered mirror and EF the glass plate: ordinary light reaches the analyzing prism from CD and linear polarized light from EF.

(*a.*) FG closed by an opaque slide: white linear-polarized light.

(*b.*) FG closed by the slide, in HF a colored glass: according to the nature of the glass, monochromatic or polychromatic linear-polarized light.

(*c.*) Colored glass at FG, HF open: unpolarized colored light and white linear-polarized light. The cross is seen brightly colored in the tint of the glass.

(*d.*) A colored glass at HF, FG open: colored polarized light with unpolarized white light. The rings become almost invisible.

(*e.*) Differently colored glasses at HF and FG. The rings appear as if the analyzing prism had been turned 90°; the cross is colored and the rings appear in the tints of the two glasses.

(*f.*) If a rotating mica plate be placed at HE the corresponding combinations of circular and elliptical, with unpolarized light are obtained.

2d. The silvered mirror CD is replaced by the blackened polarizing mirror. Two beams of light linearly polarized in the same plane, or if the mica plate at HE is used, circularly or elliptically polarized, reach the Nicol's prism.

They are (*a*), both white or both colored, (*b*) white and colored, (*c*) differently colored, according to the arrangements made.

3d. Between the mirror CD and the plate of glass EF, the mica plate is inserted: in this manner combinations of circularly or elliptically polarized light, with linear polarized light are obtained.

4th. The silvered mirror is placed at CD and a set of six glass plates is inserted at EF. This is so arranged that the light entering from CD and polarized by refraction in passing through EF is equal in intensity to the light polarized by reflexion at EF: the two beams are of course polarized

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at right angles to each other; no figure is formed by the crystal of calc spar—the light is unpolarized.

Interesting experiments may be be made by weakening the intensity of either of these beams of light. If now colored glasses are placed in HF and FG the phenomena of dichroitic crystals may be obtained, as follows:—

(*a.*) The calc spar crystal is removed, and the Nicol's prism exchanged for a doubly refracting rhomb of calc spar. When a round aperture is inserted at HE, two images of it are obtained in different colors; by rotating the rhomb the tints pass into one another.

Crystals improperly termed dichroitic are now represented by using plates of glass of the same color, and weakening the intensity of one of the beams of light.

(*b.*) If a crystal of calc spar cut at right angles to its axis is inserted between A and HE the phenomena are obtained which dichroitic crystals exhibit when they are used in a polarizing apparatus as an analyzing arrangement.

By the intermixture of certain spectra Prof. Dove obtained colors which could not have been expected from the components, but which corresponded to the investigations of Wünch and Helmholtz.

Prof. Dove remarks that his dichroscope can with some inconvenience be adapted to the Nörremberg polariscope.

The little polariscope figured on page 536 (or 388, 2d edition) of Silliman's Nat. Phil. is however admirably adapted to its reception as I have ascertained experimentally.—*L. and E. Phil. Mag., No.* 134, *Nov.*, p. 352.

O. N. R.

5. *Dove's 'Optical Studies.'* *—(1.) Prof. Dove found in 1851, that by combining black and white surfaces in the stereoscope metallic lustre was produced, and upon this and similar experiments founded a theory of lustre. In his Optische Studien he describes a method of producing lustre without stereoscopic combination. A pattern cut out of red paper is pasted on a sheet of green paper or the reverse arrangement may be adopted. If a plate of red glass is held before one eye and one of green before the other, the picture is seen brilliant and lustrous as though painted on glass or porcelain. A blue figure on a red field, or the reverse, when viewed through red and blue glasses give similar results.

The lustre is most striking when the drawing is viewed from above.

(2.) *On a method of mingling at will colors produced by absorption or interference.*—see Dichroscope, this Journal p. 108.

(3.) *On the influence of binocular vision upon the estimation of the distance of bodies seen by reflexion and refraction.*—The following is a striking experiment. A cube of clear glass 2 inches in diameter was placed upon a colored glass cube 1 inch in diameter. When viewed with both eyes from above, the colored glass appeared to be converted into a four sided prism of double the height. (A piece of glass 1 inch thick with two parallel sides, placed on a cork ½ inch in diameter shows this very deceptive phenomenon quite well.) If print be viewed through a large rhomb of calc spar by both eyes it will be seen that the two images do

* Optische Studien, by Prof. H. W. Dove, Berlin, 1859.

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not lie in the same plane. This effect is imitated by Prof. Dove in two printed stereographs—see Sept. No. this Journal, p. 304.

[If a printed page be magnified by a plane convex lens 3 inches in diameter 2½ in focal length, and viewed by both eyes, it will be seen that the letters are raised in the centre of the field, so that it instead of appearing flat seems to be convex. A single projection of a pyramid placed under the centre of the lens gains relief, though the lines drawn from the base to the apex rise toward the observer in curves. The effect is due to the distortion produced by viewing the drawing through the opposite halves of the lens.

On the other hand if two perfectly similar printed pages be viewed through the lenticular stereoscope, attentive examination will show that the field is apparently concave: the lines rising in shallow tiers, above and below; this is of course a defect in the instrument, since it alters the relief in which the objects are seen, increasing or diminishing it according to their position in the field.

On this account it may perhaps be advisable even where the most natural relief is desired to place the cameras somewhat farther apart than the distance between the eyes. Sir David Brewster, in his work on the stereoscope, page 108, gives us to understand that Wheatstone's reflecting stereoscope is not a "real optical instrument"(!) because pieces of *looking-glass* are employed in it. Must we now strike Sir David's lenticular stereoscope from the catalogue of optical apparatus because *semi-lenses* are employed in it, which alter the natural relief, in which according to the same author it is so *essential* that objects should be viewed?]

(4.) *An interesting article on the application of the Stereoscope to distinguish copies from fac-similies.*—When two pages printed from the same type are combined in the stereoscope the printing appears to lie in the same plane—(in the lenticular stereoscope to be evenly distributed over a shallow concave surface). In the most careful attempt by the printer to set up a page or a few lines alike, the words and letters will in the stereoscope be seen to lie in different planes.—(See the illustration on page 304, vol. xxx, this Journal.)

By this means when genuine and counterfeit bank notes are combined in the stereoscope the difference is at once detected. This is really a method of apparently converting distance in a horizontal, into depth in a vertical plane and greatly magnifying it.

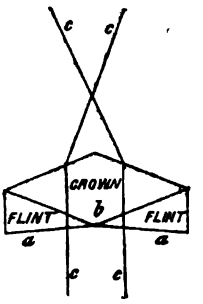
(5.) *Upon the Electric Light,*—being an analysis of the weaker varieties of electric light by means of colored glasses. In passing from nearly invisible electric light to the electric spark, the changes are as though the spectrum was slowly uncovered by the withdrawal of a screen whose motion was in a direction from the violet toward the red. This makes it improbable that the increase of intensity in electric light is due to an increase of heat in the particles torn from the conductors. The action is more like that of the pale flame of hydrogen which becomes bright and white by the introduction of solid matter. O. N. R.

6. *Improvements in the Microscope.—Wenham's Improved Binocular Microscope.*—In the Quarterly Journal of Microscopical Science for July, 1860, Mr. Wenham has described an improved form of Binocular Microscope. The construction of this instrument will be understood from the

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accompanying figures. The rays from the two sides of the object glass are transmitted through a compound achromatic prism shown in fig. 1, by which they are made to cross each other and diverge at an angle of 16°, so that at the distance of about eight inches the rays from the right side of the object enter the left eye, and the rays from the left side enter the right eye as shown in fig. 2.

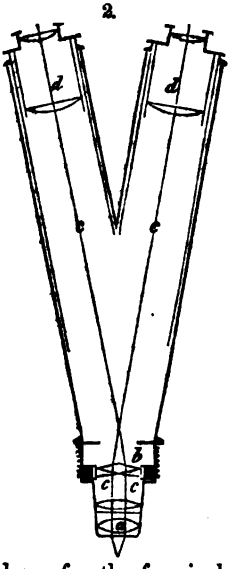
1.



Two prisms of flint glass *a a*, fig. 1, are cemented to a single four-sided prism *b* of crown glass; the angles of the prisms having such a relation to the refractive and dispersive powers of the two kinds of glass as to make the compound prism achromatic and give to the opposite pencils the proper convergence after leaving the prism. In an instrument of this kind, made under the direction of the writer, by Messrs. Grunow, the flint prisms have each a refracting angle of 26°, the lateral angles of the crown prism are 44°; the opposite faces of the crown prism are parallel; the refractive index of the flint glass is 1·621 and of the crown glass 1·534 and the dispersive powers of the flint and crown prisms are as 1·000 : 0·625.

In fig. 2, *a* represents the object-glass of the microscope, *b* is the compound prism, *c c*, *c c* show the position and direction of the two lateral pencils, and *d d* are two eye-pieces at the extremities of the two branches of the compound body and the microscope.

2.



Each branch of the compound body is furnished with a draw-tube which can be extended 2 or 3 inches if necessary. By this means the instrument can be adjusted to different eyes. When the draw-tubes are closed, the distance between the centres of the eye-pieces is 2 inches, and when drawn out two inches, the distance apart is 2½ inches. This is as great a range as is required to suit the eyes of most persons who wish to use the microscope.

A great superiority of this binocular microscope over other forms, as Nachet's and Riddell's, results from the extreme thinness of the achromatic prism. In both of the other forms named, the light twice suffers total reflection, and passes through a thickness of an inch or more of glass causing much aberration and loss of light. In the form described above there is little loss of light or aberration, as the greatest thickness of the achromatic prism does not exceed one fourth of an inch. Another excellence is the lightness and simplicity of construction and the facility with which it may be adapted to the ordinary microscope. In microscopes having a horizontal arm, the ordinary compound body can be changed for the binocular body and either may be used at pleasure. The instrument of this kind made for the writer gives great satisfaction

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to all who have seen it. The stereoscopic effect is perfect; vascular and cellular tissues, and mucous membranes are shown in bold relief; and a magnifying power of 200 to 300 diameters can be used with reflected light with entire satisfaction. With transmitted light the higher powers can be used on suitable objects.

Note.—There is one defect in this form of binocular microscope, viz., object glasses of large angular aperture take in light from so great a field that a portion of light enters the branch of the compound body on the same side from which it originates. This gives, with *low powers*, as the 1 inch and 2 inch objectives of large apertures, a supernumerary image that interferes somewhat with the definition of that part of the field under examination. This defect diminishes as the objective is removed to a greater distance from the prism. If this defect can be obviated, this form of binocular microscope will undoubtedly prove greatly superior to all other forms yet devised. M. C. WHITE.

New Haven, Dec. 7, 1860.

7. *Tolles' Orthoscopic Eye-piece.*—Among the recent valuable improvements of the microscope we notice as worthy of mention a new form of eye-piece made by Mr. R. B. Tolles, of Canastota, N. Y. This is a modification of the Solid Negative Eye-piece for which Mr. Tolles received a patent, Sept. 1855. The new eye-piece consists of a double convex field-lens, about three-fourths of an inch thick, and a plano-convex eye-lens. The image is formed in the solid substance of the field-lens. This instrument is so constructed as to give a flat field, the central and lateral portions being in focus at the same time, and the magnifying power is the same throughout, so that lines are shown perfectly straight in whatever part of the field they may be seen. Mr. Tolles also combines a micrometer with this eye-piece, by constructing the thick field-lens of two parts cemented together and by ruling micrometer lines on one of the plane surfaces of union. This eye-piece either with, or without the micrometer is highly satisfactory, giving very fine definition throughout the entire field. This eye-piece will be received with great favor by all who work with the microscope. M. C. W.

8. *Contributions to Analytical Chemistry.*—From an elaborate memoir by H. ROSE, we extract the following notices which are of special interest and importance.

Alumina from Lime and Magnesia.—In the ordinary method of separating alumina from lime and magnesia by means of ammonia, the precipitate of alumina is apt to contain portions of the carbonates of the earths, which of course cannot be removed by washing. To avoid this difficulty, it is only necessary after precipitating by ammonia, to boil the whole gently until there is no longer any smell of free ammonia. In this manner, the alumina is completely precipitated while the whole of the carbonate of lime or magnesia is decomposed and dissolved by the ammoniacal salt present. It is of course necessary that chlorid of ammonium or some other ammoniacal salt should be present in sufficient quantity.

The precipitated alumina is very difficult to wash out upon the filter; it is therefore better after bringing it completely upon the filter, to dry the whole partially till the alumina has shrunk together and just moistens the paper when pressed against it. The alumina may then be easily and

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completely washed with hot water. The separation of lime from alumina by this method is complete, but extremely small traces of magnesia usually remain with the alumina.

Separation of Oxyd of Iron from Lime and Magnesia.—By precisely the same method, oxyd of iron may be separated easily and completely from both lime and magnesia. The oxyd of iron may be readily washed out by hot water, and is not gelatinous like alumina.

Separation of Alumina and Iron from Manganese.—Alumina may be easily separated from manganese by the same method. The precipitated alumina sometimes however contains traces of manganese which are too small to be detected by the blowpipe. The same process may be employed directly in separating manganese from iron, when the quantity of manganese is comparatively small. When however this is not the case, the precipitated oxyd of iron contains a considerable quantity of manganese which cannot be removed by boiling with the solution. The oxyd of iron must then without previous washing be dissolved in chlorhydric acid, again precipitated with ammonia, and the solution boiled till the free ammonia is expelled. It is also necessary in separating the bases by this process to bring the solution to the boiling point before adding ammonia, and to boil without intermission till all the free ammonia is expelled. In this manner, we avoid the formation of traces of sesquioxyd of manganese. When iron, manganese, alumina, lime and magnesia are present, and the quantity of magnesia is not too large, the solution may be saturated with chlorine, precipitated by ammonia, and the alumina, iron and manganese separated from the other bases by boiling with the solution. The manganese may then be separated from the alumina and iron by a precisely similar process.

Separation of Manganese from Magnesia and Lime.—This is best effected by adding acetate of soda to the solution, heating and passing a current of chlorine gas through it while hot. The purple red solution is to be supersaturated with ammonia and boiled till the free ammonia is expelled. The manganese is precipitated as sesquioxyd, while the magnesia remains in solution. When alumina and magnesia are present with the manganese, it is best to precipitate the alumina by carbonate of baryta, and then to separate the two other bases by the method already described. To separate manganese from lime, chlorine may be passed directly into the solution; ammonia is then to be added and the whole boiled as before. When alumina, manganese, lime and magnesia are present the dilute solution is to be oxydized by chlorine, and then the alumina and sesquioxyd of manganese precipitated by ammonia and the solution boiled till the free ammonia is expelled.

Separation of Strontia from Lime.—The best method of separating these bases, according to Rose, is the old process of Stromeyer, viz: by treating the nitrates with anhydrous alcohol, which dissolves the nitrate of lime. This process may be greatly improved by using a mixture of equal volumes of ether and alcohol. In this mixture the nitrate of lime easily dissolves, while the nitrate of strontia is almost absolutely insoluble.—*Pogg. Ann., No.* 6, 1860. W. G.

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TECHNICAL CHEMISTRY.

9. *Test for Fusel Oil;* by W. STEIN.—Small bits of porous chlorid of calcium having been placed in a beaker glass, portions of the spirit which is to be tested are added until the mass is moistened to such an extent that it appears wet. The beaker is then covered with a glass plate and left to itself. If the spirit contains fusel oil, the odor of the latter may be detected after a while in the beaker, being still more strongly manifest, after the lapse of several hours. When only minute traces of fusel oil are present, one must allow the mixture to stand for a considerable time, before smelling of it.

According to Stein, this method is only a modification of the common test in which the spirit to be investigated is thrown into warm water. Since the impossibility of perceiving small portions of fusel oil in spirit depends upon the fact that the odor of this substance is masked by that of the alcohol vapor which is evolved at the same time, the formation of the latter must be prevented if one wishes to smell the fusel oil alone. This result may be attained either by diluting the alcohol with water, or better, as previously stated, by mixing with it an excess of chlorid of calcium, with which substance the alcohol combines so strongly, that its odor can no longer interfere with that of the fusel oil.—From *polytechnisches Centralblatt*, 1859, p. 1627; in Dingler's *polyt. Journal*, clv, 158.

10. *Value of different kinds of Soap;* by R. GRAEGER.—Complaints of consumers in regard to the value, or rather efficacy of samples of soap, which to the best of the manufacturer's knowledge, have been well prepared, are not uncommon.

It is very probable that the usual explanation which is offered, whenever a soap fails to fulfil the expectations of its consumer, viz: that it contains too much water, may be in many cases correct. Admitting this, and various other contingences, which are of importance in deciding upon the value of a soap, there appears to be another obvious reason why different soaps containing equal amounts of water may still possess different degrees of efficacy.

It is evident from the different equivalent weights of the various fatty acids, that the amounts of caustic alkali taken up by them in the formation of soap must be of unlike magnitude.

If it be true, that the detergent power of soap is entirely dependent upon the amount of alkali which it contains, of course it follows that those soaps which contain the largest proportion of alkali,—or in other words, those containing a fatty acid, the equivalent weight of which is small,—must be the most efficacious.

Since the difference between the equivalents of the common fatty acids are not large, these considerations are perhaps of little or no importance in so far as concerns the consumption of soap in household economy—the total amount used in a single family, being but small. In a manufacturing establishment, however, where fifty or a hundred thousand pounds of soap may be used, in the course of a year, differences which cannot be deemed insignificant, must exhibit themselves.

For example, the equivalent weights of several soaps, (regarded as anhydrous,) in common use, are as follows:

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Oleic acid (red oil) soap,	-	-	-	= 3800·95
Palm oil	"	-	-	= 3588·85
Tallow	"	-	-	= 3300·95
Cocoanut oil	"	-	-	= 3065·45

Calculating from these weights how much of each of the other soaps would be required to replace 1000 pounds of tallow soap, the following quantities will be found:

1151 lbs. of Oleic acid soap, *i. e.*, 15·1 p. c. more than of tallow soap.
1087 " " Palm oil soap, *i. e.*, 8·7 " " "
928 " " Cocoanut oil soap, *i. e.*, 7·2 " less than "

Differences like these must certainly be of importance in practice; and could, doubtless, be detected by direct experiment, if any one would undertake a comparison of the various kinds of soap,—a research which would not be easy however.—*Bœttger's polytechnisches Notizblatt*, 1860, xv, 65.

11. *Pig-iron which contains Copper cannot be puddled;* by Dr. C. List.—It has been stated as a matter of belief among practical iron-workers in Germany, that pig-iron which contains copper cannot be puddled; assertions having even been made, that when one puddler wishes to annoy another he will sometimes throw a bit of copper—a small coin, for example, into the furnace, so that the iron cannot be made to "rise."

Without giving full credence, as yet, to this statement, Dr. List mentions that he has observed two instances, which go to prove that it may be correct. In the case which he has more particularly described, none of the phenomena which ordinarily occur, when iron is puddled, appeared. Some 400 lbs. of pig-iron having been placed in the furnace were melted in the course of half an hour,—at which time a sample taken from the molten mass was perfectly white, but the usual evolution of carbonic oxyd and consequent swelling, or "rising" up of the mass of scales, &c., about the iron, did not ensue. On the contrary, by the time that the balling together of the iron should have commenced, it was evident, that the charge could not be worked off; it was therefore removed from the furnace, after having remained there about three quarters of an hour. As the melted metal was flowing out, it emitted numerous beautiful blue sparks, which were also produced, when the metal in the furnace was stirred. The sparks were regarded by the workmen as an indication that the iron contained copper.

The amount of metallic iron, which remained, weighed 240 lbs., 160 lbs. having been lost in the scales and slag. Analyses [for details of which, see the original memoir,] were made of the original pig-iron, (I.); of the sample taken, as previously mentioned, from the melted iron, as it lay beneath the scales, (II.); and of the iron, after it had been removed from the furnace, (III).

	I.	II.	III.
Silicon, - - -	1·32	0·29	...
Sulphur, - - -	0·28	...	0·20
Manganese, - - -	3·56	...	0·48
Copper, - - -	0·35	0·38	0·57

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It was evident, therefore, that the 400 lbs. of pig-iron used did really contain nearly a pound and a half of copper. It appears, moreover, that copper cannot be removed from iron by puddling. Calculating how much copper ought to be left in the iron which was finally removed from the furnace, in case none had been lost in the slag, it is found that there should be 0·58 per cent, almost exactly the quantity obtained in analysis No. 3.—*Dingler's polytechnisches Journal*, 1860, clv, 22.

F. H. S.

12. *Preparation of Oxyd of Lead free from Copper and Iron;* by TH. WICHMANN.—Of the many plans which have been proposed for utilizing the sulphate of lead which is formed in considerable quantity as a secondary product in the preparation of alumina mordants at print works, the method of reducing it in furnaces to the metallic state has been most frequently resorted to, since the quality of the lead thus prepared is of peculiar excellence. Instead of thus reducing the sulphate of lead, Wichmann proposes to convert it directly into oxyd of lead, maintaining that the oxyd thus prepared being uncontaminated with copper or iron will be well suited for the manufacture of white glaze for pottery—[probably also for making flint glass] it being somewhat difficult to obtain in commerce oxyd of lead which does not contain traces of these impurities. In his method, suggested by that of Mohr* for preparing caustic baryta, a quantity of caustic soda lye of from 28° to 30° (B.)= about 1·25 sp. gr., having been brought to boil in an iron kettle, the sulphate of lead is added to it little by little, with constant stirring, oxyd of lead and sulphate of soda being produced. The amount of sulphate of lead which shall be added to a kettle of soda, and which is somewhat less than the quantity which theory would indicate, must be determined once for all by direct experiment,† sulphate of lead being added until the sharp caustic taste of the soda is no longer manifest. It is well, however, to leave some free soda in the solution lest a portion of undecomposed sulphate of lead should contaminate the oxyd of lead which is formed, although a small amount of the latter will combine with the soda and remain in solution. During the boiling, the decomposition is rapid, and complete, unless the soda lye contained much carbonate of soda in which case a white scum of carbonate of lead will separate.

* To a boiling solution of caustic soda, of 1·10 to 1·15 sp. gr., of known strength an equivalent weight of powdered nitrate of baryta is added. As soon as the baryta salt has completely dissolved, the hot solution should be rapidly filtered in order to separate any sulphate or carbonate of baryta which may have been formed from impurities of the soda, and the filtrate set aside in a cool place. An abundant crop of crystals of hydrate of baryta soon forms. These crystals are to be drained from the solution of nitrate of soda, upon a funnel loosely plugged with cotton and the drying completed [according to Mohr] by means of a centrifugal machine. If required for purposes where the adhering nitrate of soda should be avoided the hydrate of baryta may be re-crystallized. In place of the nitrate of baryta one may use chlorid of barium—or in place of the soda, potash; but as a rule the presence of chlorine in the product would be more objectionable than that of nitric acid. On the small scale the process of boiling is best conducted in a glass flask, but where larger quantities are desired a covered iron kettle may be used—as in the common method of preparing caustic alkalies.—From *Archiv der Pharmacie*, lxxxviii, 38; in *Chemisches Centralblatt*, 1856, [N. F.,] i, 834.

[† For a ready method of obtaining the weight of moist sulphate of lead, see Mr. F. Mayer's paper in the March No. of this Journal, [2], xxix, 280.]

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When the proper quantity of sulphate of lead has been added to the lye and the decomposition is finished, the contents of the kettle must be thrown into a vessel containing water in order that the sulphate of soda which has been formed may be retained in solution, which would not be the case if no water were added to the mixture. The oxyd of lead, which is in the form of exceedingly fine crystalline scales of a light yellowish red color* and of great purity, is readily deposited; after being thoroughly washed, to remove the sulphate of soda, it is dried and finally ignited in a reverberatory furnace—the charge being subsequently allowed to cool as slowly as possible.

As thus prepared the oxyd is an exceedingly soft powder of a yellowish red color like prepared litharge; it contains about 2 per cent of alumina which can not readily be removed, but which is not at all detrimental to its use in glazing pottery, and also a larger or smaller quantity of carbonate of lead according as the soda lye was more or less contaminated with carbonate of soda.

The crude sulphate of lead as it comes from the print works should be agitated and washed with water—or, better, forced through a fine seive in order to break up lumps and to remove any foreign substances,—before being used.

The residual solution of sulphate of soda being evaporated together with the first portions of the wash water, affords Glauber's salt containing alumina, plumbate of soda, acetate of soda (the acetic acid and alumina being both derived from the crude sulphate of lead), and chlorid of sodium (from the soda lye); being free from iron, it is suitable for glass maker's use.—From *Polytechnisches Centralblatt*, 1860, p. 411; in *Polyt. Notizblatt*, xv, 184.

13. *Cleansing of Mordanted Cloth before Dyeing;* by J. Lœwenthal. —It is well known that cotton cloth upon which alumina or iron mordants have been printed must be submitted to the so-called dunging process before it can be dyed.

The action of the ingredients used for dunging is:—1. to completely fix the mordants: 2. to remove the substance (starch, gum, &c.,) with which the mordant was thickened for printing; (3. as well as to remove the excess of mordant, and by combining with it prevent it from soiling those portions of the cloth which are to remain uncolored.—E. Kopp.)

Giving special prominence to the second of these desiderata, that of removing the thickening agent, Lœwenthal proposes to employ diastase, as contained in malt, in order to convert the starch into sugar thus rendering it readily soluble so that it can be easily removed from the cloth.

By direct experiment he has satisfied himself that the addition of malt to baths of bran (previously boiled) or of cowdung, is decidedly beneficial; cloths which have been printed with an alumina mordant thickened with starch being very rapidly cleansed in this manner. With iron mordants a somewhat longer time is required than with those of alumina but they are nevertheless cleaned much more rapidly than when no malt is used.

A temperature of 35° to 40° R. [=111° to 122° F.] is sufficient that the malt shall act powerfully.

* If a more concentrated soda lye be used, say of 40° B., somewhat larger crystals of a dark red color are formed.

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When the dunging bath contained water glass (sesquisilicate of soda) the use of malt gave rise to the formation of spots upon the cloth in the process of dyeing. The author thinks, however, that this objection might perhaps be obviated if purer diastase were used instead of malt.

In this connection Barreswil remarks that he has employed pepsine with success in removing colors fixed with albumen.—*From Journal für praktische Chemie*, lxxix, 480; *in Répertoire de Chimie Appliquée*, ii, 168.

14. *Incineration of Filters.*—The great difficulty with which in many cases, the last portions of the carbon of a filter are consumed when ignited in a porcelain crucible is a fact well known to analysts. It does not appear, however, that the following simple method of obviating the difficulty—as practised in the laboratory of Prof. Scheerer in Freiberg—has ever received the publicity which it deserves.

Whenever a filter upon which a substance capable of injuring platinum has been collected is to be incinerated, the porcelain crucible or capsule in which the process is to be conducted should be placed *within a vessel of platinum* of similar form, and the whole ignited in the usual way.

Whether the greatly accelerated rapidity of combustion of the carbon, which ensues depends upon a more equable distribution of heat brought about by the greater conducting power of the metal,—an explanation which is current for the somewhat analogous case of copper-coated glass flasks, or whether as seems probable, the power of the porcelain vessel to absorb heat be really increased by the interposition of the platinum; whether both these causes be of influence, or the result depend upon another less apparent reason; or finally whether vessels of some other metal would not be preferable to those of platinum; are questions which we do not propose to discuss in this connection. We desire only to give currency to the *fact* to which attention has been called, feeling assured that the chemist who has once employed this method to destroy a refractory filter will ever afterwards bear it in mind. F. H. S.

15. *On the occurrence of the Hydrocarbon* C_4H_2 *in Coal Gas.*—In describing the explosive red compound* which he obtained by passing a current of street gas through an ammoniacal solution of dichlorid of copper, Böttger (*Ann. Ch. u. Pharm.*, cix, 353), called attention to the fact that an abundant evolution of gas ensues when the compound is treated with moderately concentrated chlorhydric acid. This gas has recently been more carefully examined by Berthelot (*Comptes Rendus*, l, 805), who finds its composition to be C_4H_2, and calls it *acetylene*, or quadricarbide of hydrogen. It is evidently the prototype of a series of hydrocarbons, the general formula of which is $C_{2n}H_{2n-2}$. According to Berthelot, acetylene is formed whenever olefiant gas, or the vapor of alcohol, ether, aldehyd, or of wood-spirit is passed through a red hot tube.

* This explosive compound has also been described by Quet, (*Comptes Rendus*, 1858, xlvi, 905), who obtained it when the gas prepared by decomposing alcohol by a series of electric sparks was treated with an ammoniacal solution of dichlorid of copper. It was observed in 1839,—long before the experiments of the chemists above mentioned, by Prof. Torrey of New York, on the occasion of its occurrence in the copper service pipes at that time in use for distributing gas. (See *American Gas-Light Journal*, Oct. 1859; *Répertoire de Chimie Appliquée*, i, 493; compare Böttger's *Notizblatt*, 1860, xv, 117), (note).

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It is formed also when the vapor of chloroform is brought in contact with red hot copper; and is moreover a constituent part of illuminating gas. Of the foregoing sources, ether furnishes it in the greatest abundance. In whichever of these methods the gas may have been prepared, however, it is always mixed with a large quantity of other gases, from which it must be separated in the manner indicated by Bœttger before it can be obtained in a state of purity.

Acetylene is a colorless gas, somewhat readily soluble in water, having a disagreeable and characteristic odor, and burning with a very luminous and smoky flame. Its sp. gr.=0·92; it has not been liquified either by cold or pressure. Mixed with chlorine it detonates almost immediately even in diffused day light, carbon being deposited. When exploded in the eudiometer 1 volume of acetylene consumes 2·5 vols. of oxygen and forms 2 vols. of carbonic acid. Its formula represents 4 volumes of vapor.

In general the properties of this gas are similar to those of olefiant gas (C_4H_4); and by combining with bromine, sulphuric acid, the elements of water, and with hydrogen, it forms compounds parallel to those formed in similar cases by olefiant gas.

[In a technological point of view this gas is of great interest; for not only is Berthelot's observation of the first importance in itself as a contribution to the chemistry of gas lighting, but further investigation of the subject will no doubt lead to the elucidation of several of the vexed questions upon which gas engineers are at variance. For example, the fact that a quantity of useful gas—probably much more luminous than an equal bulk of olefiant gas, is produced when the latter is strongly heated, must be a most acceptable support to those who advocate "high temperatures" as the best system of gas making;—as it must also materially modify, the prevailing notion that the luminiferous properties of olefiant gas are entirely destroyed by such treatment. In a word, those who from theoretical premises have satisfied themselves that the employment of "high temperatures" in gas making is pernicious, and have therefore opposed this system, must reconsider their argument.*

Again, the knowledge that a luminiferous gas so readily soluble as acetylene occurs in coal gas is a subject most worthy the consideration of those gas engineers who advocate the use of much water in the purification,—or who, in the terse language of the opponents of their system, "would 'scrub' the life out of the gas!"

The occurrence of acetylene, and no doubt of some of its homologues, in illuminating gas is moreover another evidence of the error, still frequently fallen into by chemical writers, of attributing all the luminif-

* We would in no wise affirm either that the researches of Berthelot and Bœttger have demonstrated the excellence of the system of high temperatures, or that it would be advantageous in practice to decompose olefiant gas for the sake of the resulting acetylene, nor would we in any way imply that the constantly increasing growth of this system is due to the good quality of the gas produced,—for this last is in many instances most certainly not the case; the rise and progress of the system abroad having been mainly due to a most unhealthy competition among rival gas companies. We urge only that the system of high temperatures contains one favorable element which had hitherto been overlooked by chemists. F. H. S.

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erous power of coal gas to the olefiant gas, and homologues of the series $C_{2n}H_{2n}$, contained in it. The incorrectness of which view has been shown by Frankland, (*Ann. Ch. u. Pharm.*, lxxiv, 57. See also lxxxii, 1), by Lewis Thompson (Ure's *Dictionary of Arts*, &c., 4th edit., Boston, 1853, i, 438), and by others, and has been recognized, we believe, by every chemist who has latterly made a special study of the technology of gas making.

Berthelot promises soon to publish the results of his examination of the compounds which acetylene forms with chlorid of copper and with nitrate of silver* and of mercury, and of the analogous compounds which the last two salts form with olefiant gas. He also alludes to a method of isolating olefiant gas, the publication of which can hardly fail to interest gas makers.

It is to be hoped that in the same connection M. Berthelot will make some slight allusion to the labors of Edmund Davy, (*Annalen der Pharmacie*, xxiii, 144; from the *Records of General Science*, Nov. 1836, through *Journal de Pharmacie, Mars.*, 1837, p. 143), who obtained from the decomposition by water of the brown mass—"carbide of potassium"—which occurs in the preparation of potassium from burnt tartar and charcoal, a gas† of the same composition (C_4H_2) and of identical properties with that which forms the subject of this notice.

Besides this, the observations of Courbe, (*Annales de Chimie et de Physique*, 1838, (2,) lxix, 184: compare Gmelin's Hand Book, x, 411, and xi, 395), should be remembered. In a liquid which was deposited by illuminating gas (from rosin) when this was subjected to pressure, Courbe detected compounds, (for example, "B"$=C_{10}H_8$, and "F"$=C_{12}H_{10}$), which accord with the general formula of the acetylene series, and which in view of their origin would seem to be entitled to a place therein, at least until their right to the position shall have been disproved. So also, perhaps, with the campholene ($C_{18}H_{16}$) of Delalande, (*Ann. Ch. et Phys.*, [3], i, 125).

While the labors of these chemists do not in the least degree detract from the intrinsic value of Berthelot's observations, they should nevertheless neither be lost sight of nor passed over in silence]. F. H. S.

16. *Action of Carbonate of Soda on Cast-Iron.*—In July, 1857, C. Tissier, director of the Aluminium Works at Amfreville, published in the *Technologiste*, (p. 357), some interesting experiments on this subject, an abstract of which we now make from Dingler's Polytechnisches Journal, cxlvi, 118, (1857). Tissier's attention was first drawn to the fact that the mixture of carbonate of soda, chalk, and charcoal used in the manufacture of sodium, notwithstanding the great excess of carbon it contains—does not affect the malleability of the iron of the retorts which are employed. He found further, when a piece of *cast iron* was submitted to a high temperature, with this mixture, that it was first converted into *steel*,

* Compare Bœttger, *loc. cit.*, also Vogel and Reischauer, in Kopp and Will's Jahresbericht der Chemie, für 1858, p. 208.

† This gas was called klumene by Leopold Gmelin, in his Hand Book (Cavendish Soc. Ed., viii, 150).

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and finally into *malleable iron.* This led him to try the effect of the action of carbonate of soda alone on both malleable and cast iron—malleable iron thus treated, remained unchanged, while the soda salt extracted the carbon and silicium from the cast iron, thereby converting it into infusible malleable iron.

If a specimen of pig-iron (that experimented on contained 6·6 pr. ct. of silicium and free carbon) be exposed for several hours at a red heat in a crucible containing an excess of carbonate of soda, the following reactions may be observed: As soon as the temperature is sufficiently elevated the mass commences to rise and large bubbles of carbonic oxyd are given off, burning with a yellow flame. If after the evolution of carbonic oxyd has ceased, the fire is allowed to go down and the iron taken out with tongs, and freed from adhering salts by means of a hammer and by water, the metal exhibits a completely etched surface, although the form of the mass is unaltered—it may be drawn out under the hammer and forged either hot or cold, and the granular fracture of the cast iron is replaced by a fibrous crystalline texture—the mass is porous, the little cavities being filled with white silicate of soda, formed from the silicium contained in the metal. The iron thus obtained is scarcely attacked at all by chlorhydric acid in the cold, and but slowly even when heated. Dilute nitric acid acts upon it with energy, but still not so rapidly as in the case of ordinary malleable or cast iron.

Tissier considers it conceivable that this action of carbonate of soda not only extracts the carbon and silicium but also must remove the phosphorus and sulphur contained in the iron. It is further possible that the iron takes up a portion of sodium, which does not injure it, but on the contrary the metal acquires desirable properties as evinced by the fact of the dealers being very willing to purchase the worn out retorts from the sodium works. If sodium be not thus taken up, we must assume that for every equivalent of carbonic oxyd an equivalent amount of anhydrous soda is formed. Tissier suggests that in the process of annealing or the conversion of cast iron into malleable iron, now accomplished by packing and heating for a long period with substances rich in oxyd of iron, it may be possible to substitute fusion with carbonate of soda, it possessing the advantage that the metal can be removed from time to time to watch the progress of the conversion into *steel* or *malleable iron.*

The author hoped by this method to convert large masses of cast-iron into malleable metal, such as heretofore could only be obtained by forging, but the length of time required for the conversion of a mass of any considerable thickness and the porosity of the iron obtained, present practical difficulties requiring some modification to overcome them. With smaller castings, however, the action, even when superficial, imparts to them great toughness so that they no longer are liable to fracture. The amount of carbonate of soda required, when properly used, is inconsiderable, but it should be pure, or if the commercial article be used, it must first be heated with carbon in order to reduce the sulphate of soda to sulphid of sodium, as the alkaline sulphates have a powerful action on iron at a red-heat.

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II. GEOLOGY.

1. *Geological Survey of Canada.—Report of Progress for* 1858. Montreal, 1859, 8vo, pp. 263, with 4 Maps and Sections.—In the present volume Sir William Logan continues his description of the distribution of the rocks of the Laurentian series. These stratified rocks, the oldest not only of America but probably of the world, have long been regarded by the officers of the Geological Survey of Canada, as identical with the oldest crystalline rocks of Scandinavia and Scotland; and Sir Roderick Murchison in his late admirable investigations of the geology of his native Highlands has recognized the parallelism, and adopted the name of Laurentian for the oldest Scottish rocks, which he had formerly designated as *fundamental gneiss*. Laurentia is destined to be a domain second only in importance to Siluria, embracing, as it does, in Canada, a mass of strata probably equal in amount to the whole palæozoic series in its greatest development, and including not less than three limestone formations, the most considerable of which is 1000 feet in thickness. These are associated with gneiss, quartzite with garnets, and great beds of rock made up of triclinic feldspars, (labradorite, or andesine,) often with hypersthene or pyroxene. Argillites appear to be wanting throughout the system. The whole of this great series of sediments is profoundly altered, yet the existence in the limestones of forms resembling *Stromatocerium*, not less than the presence of beds of graphite, iron-oxyd and metallic sulphurets, points to the probable existence of life during the deposition of these most ancient strata. (This Journal, [2], xxx, 134.)

Intrusive rocks are not generally met with in the Laurentian series, but in the vicinity of Grenville, there are injections of syenite, orthophyre, and dolerite, making four distinct periods of eruption, of which three at least were anterior to the deposition of the lowest Silurian strata.

The difficulties attendant upon the investigation of a disturbed region like that presented by the Laurentian rocks in Canada or in Northern New York, are enhanced, by the fact that it is still to a very great extent covered by primeval forests. The outcrop of the limestones, however, is generally marked by valleys, well watered and with a fertile soil which has invited settlers to some distance from the frontier of the region, and the result of two years of investigation has enabled Sir William to trace out the distribution of these limestone bands through the counties of Ottawa and Argenteuil, including fifty miles of the valley of the river Rouge; from the map of this exploration, which accompanies the Report, we may get an idea of the complexity of structure in this region. After some new observations upon the great beds of magnetite belonging to this series, and the veins of galena, which cut alike the Laurentian strata and those of the Calciferous sandrock, the report goes on to describe the copper deposits of the Eastern Townships of Canada. These occur in strata which overlie the Hudson River shales, and are named the Quebec group. The copper occurs both in the altered and unaltered strata, and is found alike in dolomites, steatites, argillites and silicious chloritoid slates, generally disseminated in the beds, but frequently in veins of quartz and bitter spar, and more rarely with specular iron and native gold. The copper itself is rarely native, generally occurs as erubescite, copper glance or copper pyrites. The famous Acton mine is a deposit between dolomites

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and shales, and forms apparently a lenticular mass. It is a conglomerate of which the sulphurets of copper form the cement, and encloses rounded and angular fragments of calcareous and silicious rock. Similar conglomerates, but much less rich in copper, occur in other localities in the same region.

Mr. Alexander Murray makes a report upon the Thessalon and Missisanga rivers, giving the results of his topographical examinations, and contributing farther information as to the structure of the Huronian rocks, which upon Lake Huron attain a thickness of about 10,000 feet and are intercalated between the Laurentian and Lower Silurian series. They are made up of quartzites with two great bands of slate conglomerates, and masses of interstratified diorites, besides two or more bands of limestone, whose distribution has been most serviceable in making out the structure of the region. The copper of the Bruce and Wellington mines, of Root River and Echo Lake occurs chiefly in veins cutting the diorites of this series, although the metal is also found disseminated in some of the beds. Mr. Murray has considered the disturbances of this series of rocks with particular reference to the distribution of the copper veins, and has given us a section, together with a map showing the distribution of the Huronian limestones. A remarkable dislocation occurs in the valley of the Thessalon, bringing the Laurentian gneiss in contact with the upper portion of the Huronian series by a vertical displacement of 9,200 feet.

The results obtained by Mr. J. Richardson in an examination of a part of the district of Gaspé are next given, with a map showing the distribution of the rocks. The Shickshock mountains, which are a continuation of the Notre Dame and Green Mountains have a synclinal form: and appear as a mass of crystalline schists in great part epidotic, quartzose and chloritic, running about E.N.E. for a distance of sixty-five miles and rising in points to about 3700 feet. Along their northern base the slates and conglomerates of the Quebec group, are seen dipping southward, but around their southern slope, repose the Devonian rocks. Associated with these crystalline schists are great masses of serpentine, which at Mt. Albert are seen sweeping around the base of the hills. A remarkable section here exhibits a synclinal form with an overturn dip on the south side, so that the serpentines, which are really beneath the epidotic and hornblendic and chloritic rocks, seem to overlie them. That portion of the serpentine which succeeds to the black hornblende slate is beautifully and distinctly stratified. The weathered surfaces exhibit opaque white or fawn colored bands of from one-eighth of an inch to an inch in breadth, with thinner red partings. Within, the rock is dark brown or greenish, with deep red bands, sometimes including grains of chromic iron and diallage, as well as thin layers of asbestus. The thickness of this stratified portion is about 400 feet; it is succeeded by about 600 feet of dark green serpentine, which is not distinctly stratified, and reposes directly upon black slates and limestones. The facts already published by the Canadian Survey have shown that it is impossible to regard the great masses of serpentine so common both in the Laurentian and Silurian series, as anything other than sedimentary deposits, and we think it indeed a question whether serpentine ever takes the form of an intrusive rock. (See further on this subject Mr. T. Sterry Hunt, in the Report for 1853–56, pp. 432 and 480, and this Journal, [2] xxv, 217, xxvi, 234,)

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In the present Report Mr. Hunt gives the results of a series of investigations upon the intrusive rocks of the vicinity of Montreal. These include orthophyres, some of which are very beautiful porphyries, and a great variety of trachytic rocks, passing into granites on the one hand and to phonolites on the other, besides diorites, augite rock and dolerites, some of them containing large portions of olivine. These investigations include a great many analyses of the rocks and their component minerals, and are followed by the continuation of Mr. Hunt's researches on the formation of magnesian rocks. With this investigation our readers have already been made acquainted. (See this Journal, [2], xxviii, 170, 365, xxix, 285.)

By way of Appendix to this Report, we have a catalogue of the plants and animals collected in the counties of Argenteuil and Ottawa by Mr. W. M. S. D'Urban, an accomplished young naturalist now at the Cape of Good Hope, who accompanied Sir William Logan during the summer of 1858—and made as complete a collection as possible of the flora and fauna of the district. A similar collection was made in the Lower St. Lawrence and in the district of Gaspé by Mr. Robert Bell, an assistant of Mr. Richardson. The species were determined in part by Mr. B., and part by Mr. D'Urban, Drs. Dawson, Le Conte, Lea and Mr. Binney. The collection of marine animals, obtained in part by dredging, is considerable, and an important contribution to the fauna of that region. T. S. H.

2. *Geological Surveys.*—Kentucky.—The fourth volume of this Survey now in press contains the stratigraphy and palæontology of all the coalfields of Kentucky excepting a few of the southeastern counties. It is provided with five plates and a great number of comparative sections, illustrative of the general distribution of the coal measures.

Arkansas.—The second volume of this Survey contains a geological description of all the counties not treated of in the first report. Mr. Lesquereux contributes to this volume the palæontological and stratigraphical descriptions of the coalfields of the State—a comparison of botanical distribution with the geological formations—and a catalogue of the phenogamous plants of Arkansas with short descriptions of the plants useful in agriculture, medicine, &c. This catalogue contains Nuttall's plants with those found by the Survey. The Palæontology is illustrated by six plates.

Illinois.—We have elsewhere stated, (p. 125,) some of the results of this State survey under the able direction of Mr. Worthen—the publication of this very valuable Report now awaits only the needful appropriation of money which a State so intelligent and prosperous as Illinois, cannot withhold—for a work which will be at once so useful and so honorable to her enlightened liberality.

Texas.—We hear with great regret that the able Director of this Survey has been removed from his post to make way for another person—without the means of judging of the circumstances of the case, we know too well Dr. Shumard's ability to discharge his duties, to suppose that Science will gain by the change—which we have reason to fear has been brought about by means of personal influence with the Governor of the State aided by the power of some influential scientific names.

California.—Prof. Whitney whose departure for his post of duty we noticed in our last—has reached San Francisco with all his party and outfit without loss or delay—and was making preparations to enter at once on the active duties of his post.

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CANADA.—The results of the labors of Sir William Logan and his able corps of associates—as far as they have been made public are noticed on page 122.

It is plain to all who take an interest in the progress of geology in the United States, that an active discussion is now imminent on the questions touching Barrande's primordial zone. In this discussion the 'Taconic System' of Emmons so long suppressed, will probably be again put forward. Already the contestants are sharpening their weapons, and we will not anticipate the discussion farther than to intimate that the views of the distinguished French geologist will find a warm opposition at the hands of the New York State Palæontologist, and probably also with some of the gentlemen of the Canadian Survey. The subject is already before the Boston Society of Natural History, where Mr. Marcou appears as the advocate of the Taconic System. This geologist finds evidence of the existence of the primordial fauna not only in the metamorphic black slates of Georgia in Vermont, but at the Falls of Montmorency, in the region between the Upper Mississippi and Lake Superior, near Lake Michigan, on the north shore of Lake Superior near the Pic, in the Black Hills of Nebraska, and in Texas.

NEW YORK.—Prof. Hall's third volume (text) on the Palæontology of New York, so long looked for, has been in print for some time, but has been held back to ensure completeness under the important genus Eurypterus. It is now before us, and we are assured by him that it will be speedily distributed. The Introduction handles with masterly skill the difficult subjects connected with the proper classification of the lower horizons of life in our planet. A review of this important chapter with reference to the views of Barrande will probably appear in our next. The plates for this volume are not yet all ready for delivery.

3. *Descriptions of new species of Crinoidea and Echinoidea from the Carboniferous rocks of Illinois, and other Western States;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 19. Proceed. Acad. Nat. Sci., Pa., Sept., 1860.—This paper contains descriptions of twenty-nine new species. *Platycrinus*, 3 species, *Dichocrinus*, 4; *Trematocrinus*, 1; *Actinocrinus*, 6; *Forbesiocrinus*, 2; *Zeacrinus*, 3; *Cyathocrinus*, 5; *Poteriocrinus*, 2; *Archæocidaris*, 1; *Palæchinus*, 1; *Melonites*, 1. It is suggested by the authors that the genus *Trematocrinus* of Hall is identical with *Goniasteroidocrinus* of Lyon and Casseday. If so, the latter genus will have to take precedence, from priority of publication. H.

4. *Descriptions of New Carboniferous Fossils from Illinois and other Western States;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 26. Proc. Acad. Nat. Sci., Pa. Read Oct. 23d, and published Nov. 24th, 1860.—This interesting paper comprises 69 species, all of which are supposed by the authors, to have been heretofore undescribed. They may be enumerated as follows: *Ephenopterium*, 4 species; *Palasterina*, subgenus *Schœnaster*, 1; *Chonetes*, 1; *Productus*, 3; *Rhynconella*, 1; *Athyris*, 1; *Pecten*, 1; *Aviculopecten*, 7; *Avicula*, 1; *Myalina*, 3; *Solemya*, 1; *Leda*, 1; *Schizodus*, 1; *Cardiomorpha*, 1; *Bellerophon*, 1; *Pleurotomaria*, 11; *Euomphalus*, 2; *Naticopsis*, 2; *Platyostoma*, 2; *Eunema*, 1; *Loxonema*, 5; *Eulima*, 1;

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Macrocheilus, 3; *Soleniscus*, 1; *Orthoceras*, 1; *Cyrtoceras*, 2; *Nautilus*, 7; *Goniatites*, 3.

The authors have established a remarkable new genus of Zoöphytes, *Sphenopoterium*, from σφην, a wedge; ποτηριον, a cup.

"This small group of corals appears to be more nearly related to *Cyathoceris*, of Edwards and Haime, than to any other genus, either recent or fossil, with which we are acquainted. It differs, however, in having the outer walls perforated, and in being destitute of distinct rays, as well as in the peculiar wedge-like form of the base of the corallum, which is also usually, if not always, free instead of attached."

The authors also describe a new genus of Gasteropoda, *Soleniscus*, to include certain species allied to *Loxonema* and *Macrocheilus*. The illustrations with more extended descriptions will appear in the forthcoming report of the Illinois Survey, which promises to be one of unusual interest. Besides the numerous invertebrate fossils, it will contain illustrations and descriptions of over one hundred new species of fossil fishes of Dr. J. S. Newberry; a report on the Bryozoa of Dr. H. A. Prout; a report on Fossil Plants of Mr. Lesquereux and a report on the Lead region of Illinois by Prof. J. D. Whitney. H.

5. *Systematic Catalogue, with Synonyma, &c., of Jurassic, Cretaceous and Tertiary Fossils collected in Nebraska, by the Exploring Expeditions under the command of Lieut. G. K. Warren*, of U. S. Topographical Engineers; by F. B. Meek and F. V. Hayden.—Of the 276 species and varieties enumerated in the following catalogue, 25 are from Jurassic rocks, 194 from Cretaceous, and the remaining 57 from Tertiary strata. None of the Jurassic species are known to occur in this country east of the Black Hills, or south of the middle of eastern Utah, though some of them will probably be found in New Mexico. One species is believed to be identical with *Ostrea calceola* of Roemer from the Jurassic rocks of Germany, and another (*Ammonites cordiformis*) is probably not distinct from *A. cordatus*, Sowerby, which occurs in the Jurassic series of England, France, Russia, &c. Nearly all the other Jurassic species mentioned in the list are closely allied to forms common in the lower part of that system (the Lower Oolite and Lias) in the old world, and several of them may prove identical on farther comparison.

Of the 194 Cretaceous species the following seven are common to the Nebraska and New Jersey beds, viz.—*Nautilus Dekayi*, *Ammonites placenta*, *A. complexus**, *A. lobatus**, *Scaphites Conradi*, *Baculites ovatus*, and *Gryphæa vesicularis?*; and the following five species are probably common to Nebraska and foreign localities, viz.—*Nautilus Dekayi*, *Inoceramus problematicus*, *Gryphæa vesicularis*, *Cucullæa fibrosa*, and *Micorbacia coranula*.

The 57 Tertiary species are believed to be all distinct from foreign forms, and none of them have yet been found in this country east of Nebraska, or south of northeastern Utah. They are all, so far as known, extinct species."

The Palæontological portion of Lt. Warren's report is now completed, containing extended discriptions and comparisons of over three hundred species of fossils, from all the formations known in the northwest. The illustrations comprise over one thousand figures of Mollusca and occupy forty-five quarto plates.

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6. *Observations on the Cretaceous Strata of Texas;* by B. F. Shumard, M.D., (Trans. Acad. Sci. St. Louis, vol. i, No. 4, p. 582).—The leading points in Shumard's paper bearing upon the disputed geology of the southwest are these. First he recognizes at the base of the Cretaceous series of that region, what he calls the Arenaceous group, and places it on a parallel with our No. 1, of Nebraska, (Miocene of Marcou and Prof. Heer). This is as was shown by Messrs. Meek and Hayden in 1857* a part of Marcou's Jurassic and Triassic of the *Pyramid Mountain Section.* It is also the horizon of their Cretaceous leaves of Nebraska and Kansas as Shumard states, and he finds great numbers of Cretaceous fossils in it, though no leaves.

Above this he finds other beds which he places on a parallel with No. 2 and 3, of the Nebraska section, and shows that they are the horizon occupied by Marcou's *Ostrea Marshii* and *Gryphæa dilatata,*† upon which he rests his claims to the discovery of the Jurassic of the southwest.

These beds Meek and Hayden had also placed on a parallel with No. 2 and 3, of the Nebraska section, as Shumard states. Thus as is seen, all explorers concur in the opinion that what Marcou calls Jurassic, at least, at the localities where he found fossils, is Cretaceous. There doubtless are Jurassic and Triassic rocks in New Mexico, and possibly in parts of Texas, but all the fossils Marcou relied upon to prove it, are Cretaceous species, as already stated. And the Jurassic and Triassic of his section, at the main localities cited, are Cretaceous beds. Shumard's paper is an important one, and when we consider his opportunity to understand these matters in making State explorations, is entitled to great weight. M.

7. *Die Silurische Fauna des westlichen Tennessee;* 4to. pp. 97; three lithographic and two copper plates; by Dr. Ferdinand Roemer; Breslau, 1860.—In this work Dr. Roemer has noticed and figured 58 species of fossils from the Upper Silurian rocks of Tennessee. Of these he identifies 22 as occurring in the Niagara group of the State of New York, and 28 in Europe, in the Wenlock formation of England and in the limestones of the Scandinavian Islands, Gothland and Malmö. The most interesting are those which he has described as fossil sponges under the genera *Astylospongia Palæomanon* and *Astræospongia.* The specimens are spheroidal sub-cylindrical or cyathiform like the sponges of the cretaceous and Jura formations. They are silicified and in the polished sections, numerous radiating canals with star-like groups of spiculæ are clearly exhibited, presenting an internal structure altogether analagous to that of the more recent sponges. There are six species described, one of which, *Astylospongia præmorsa* is identified with the European *Siphonia proœmorsa* (Goldfuss). Fossil sponges are rare in all the formations below the Cretaceous and Jura, but we have some reason to believe that they here occur at the very base of the palæozoic system. In addition to the American species described by Dr. Roemer we find that another form has been discovered in the lower Silurian rocks of Kentucky for which the name *Scyphia dentata* has been proposed. (See the 2d Report of the Geo. Sur., of Kentucky, page 111.) In Canada a species closely allied to Roemer's *A. stellatim-sulcata,* oc-

* Proceed. Acad. Nat. Sci., Phila., May, 1857, p. 133.

† As we had also shown in Proceed. Acad. Nat. Sci., May, 1857, p. 133.

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curs in the Trenton Limestone while two or three others have been found in the Chazy and Calciferous formations. These will be described soon in the Reports of the Geological Survey of Canada. One of the Canadian species somewhat resembles in form the *Palæotrochus* of Emmons. (See this Journal, 2d Series, vol. xxii, p. 389), and has one of the extremities covered with radiating grooves in the same manner. It seems probable therefore that *Palæotrochus* is a sponge instead of a coral. Dr. Roemer has described two new genera of Crinoids, *Lampterocrinus* and *Cytocrinus*, both of which appear to be related to *Actinocrinus*. Among the brachiopods, we find *Calceola Tennesseensis*, no doubt, identical with Prof. Saffords *C. Americana* published in this Journal in March last; the former name has the priority as Roemer has described it several years since in Bronn's Lethea Geognostica. The concluding chapter contains an interesting comparison of the Upper Silurian Fauna of Tennessee with that of the same age in Europe. All the species are well figured.

E. B.

[We have received, too late for this issue, an important paper from Prof. Safford "On the Upper Silurian beds of Western Tennessee, and Dr. Roemer's Monograph." A principal point in this paper is to indicate the fact that the fauna illustrated by Dr. R. is not the only one occurring on the 'glades.' To illustrate his subject Prof. Safford brings forward for the first time a tabular section of the order of succession and thickness of the rocks of the Upper Silurian in Tennessee. This memoir will appear in the succeeding number of this Journal.—Eds.]

III. BOTANY AND ZOOLOGY.

1. *Thesaurus Capensis, or Illustrations of the South African Flora, etc.*, by Wm. H. Harvey, M.D., F.R.S., &c.—No. 4, 1860, completes a century of plates and the first volume of this work. The plates are neatly executed and much better printed than those of the earlier numbers. The most interesting one to us is that of a Loasaceous plant, *Fissenia Capensis*, which is geographically very widely severed from all its coördinates, and has a trilocular ovary. A. G.

2. *Flora Capensis; being a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal;* by Wm. H. Harvey, M.D., F.R.S., &c., and Otto Wilhelm Sonder, Ph. D., &c., vol. I, Ranunculaceæ to Connaraceæ, Dublin, 1859–60.—An octavo volume of 546 pages, the first of the "at least five volumes" required for the completion of the Cape Flora. The second volume is in progress. Being intended for use in the Colony as well as by botanists generally, the work is written in the English language throughout. In view of this popular use, a comprehensive and excellent Introduction to Systematic Botany is prefixed, taken, with some alterations and additions, and by permission, from that in Mr. Bentham's Handbook of the British Flora; and to this is joined a set of clear and specific directions for the collection, preservation, and examination of plants. The sequence of orders adopted in the Flora is essentially that of DeCandolle. As one of the authors resides in Dublin, and the other in Hamburgh, the only course to take—and in any case the wiser course—was "to divide the work between them, each taking those Orders with which he was most familiar, and making them

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out independently, without reference to his brother author;" although, to ensure uniformity of plan, the ordinal characters and general remarks are all written by Dr. Harvey, upon whom the general editorship devolves. The descriptions are pretty full, so that only about three species appear on a page. The great knowledge and ability of the distinguished authors, and their long familiarity with Cape plants, guarantee the high character of the work, as their untiring industry and perseverance gives good hope of their bringing to a worthy and timely completion the formidable task they have undertaken. Noting that Dr. Sonder has adopted Dr. Klotzsh's genus *Dianthera*, in the Capparideæ, we beg to say that there is a Linnæan genus of that name, unaccountably neglected by recent botanists (North American ones excepted), but not rightfully to be superseded. A. G.

3. *Flora of the British West Indian Islands;* by A. H. R. GRISEBACH, M.D., Professor of Botany in the University of Göttingen. London: Lovell Reeve. Parts 1 and 2, 1859, pp. 192, 8vo.—This is another of those Colonial Floras now fostered by the British Government; indeed this is the first strictly belonging to the series. It is written throughout in English, and wonderfully good English too, considering that the author is a German. Through abbreviations and the omission of references, it is more compact than the Flora Capensis, and will probably be comprised in one or two volumes. The work is much needed, and Dr. Grisebach is doing excellent service in clearing up the manifold confusion and obscurities of West Indian Botany, and indeed of Central American Botany generally, to which he has paid much attention. The third part of this work, completing the Polypetalæ and Apetalæ combined, is, we learn, already published.

[The third part of the West Indian Flora has just come to hand. It finishes the Poly-apetalous orders, and closes the first volume of 322 pages. The larger orders it comprises are the *Leguminosæ*, the *Myrtaceæ*, and the *Melastomaceæ*, the two latter are very thoroughly and admirably re-elaborated.]

Another Flora of this series, now printing, is that of the island of Hong Kong, by Mr. Bentham. Among the most important materials for this Flora must be reckoned the collections made in that island by Mr. Charles Wright, as Botanist of the North Pacific Expedition under the command of Captains Ringgold and Rodgers, which are liberally contributed for this purpose. The same Expedition contributes also to the Flora Capensis "upwards of five hundred species of plants" from the collection of the same indefatigable botanist made whilst the vessels were detained in Simon's Bay; among which, adds Dr. Harvey, are some species not received from other collectors,—good evidence of Mr. Wright's industry and acuteness.

These qualities, and an indomitable spirit of research, are now applied to the West Indian flora; and the fruits are beginning to appear in the

4. *Plantæ Wrightianæ e Cuba Orientali*, a A. GRISEBACH;—a paper in the Memoirs of the American Academy of Arts and Sciences, vol. viii, new series, of which a small edition is separately issued for distribution among botanists. It contains many new and rare species, and the field is far from being exhausted. This paper is followed by

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5. *Filices Wrightianæ et Fendlerianæ*, etc., cura DANIEL C. EATON, A.M., an enumeration of the Ferns of this same rich Cuban collection, along with those of Fendler's Venezuelan collection, with characters of new species, etc. The sets of Fendler's Ferns issued to subscribers are exhausted; but those of Wright are still to be had, and are to be augmented by new collections. A. G.

6. *Local Botanical Catalogues.*—These are interesting as helping to determine the geographical range of our species, and also as indicating the zeal and activity of our local botanists, perhaps never greater than now. The following, published during the year 1860, are before us:—

7. *Additions to the Flora of Wisconsin;* by T. J. HALE, of the University of Wisconsin.—The number of species and varieties added to Mr. Lapham's latest Catalogue, published in 1852, "amounts to 283, of which 112 are Mosses, Liverworts, and Lichenes." The catalogue of these is contributed by Mr. Lapham. The most notable addition is that of the rare *Sullivantia Ohionis*, before known at only one station, in the central part of Ohio, but lately detected by Mr. Lapham on the Wisconsin River.

8. *Catalogue of the Flowering Plants and Ferns of Ohio;* by J. S. NEWBERRY, M.D. Originally prepared for the Ohio State Medical Society, but now published by the Agricultural Society, prefaced by some interesting remarks upon the influences, "physical, geological and climatic, which have determined the distribution of the species.

9. *A Catalogue of Plants found in New Bedford, Mass., and its vicinity;* by E. W. HERVEY. The plants are arranged according to the season of their flowering. Nine species only come into bloom between the middle of March and the first of April,—viz., the common Chickweed, the English Groundsel, which are introduced, two Poplars, two Hazels, and an Alder, *Epigæa*, and *Draba verna*. We suspect that the latter is also an introduced plant.

10. *Catalogue of the Phænogamous and Filicoid Plants of New Castle County, Delaware, arranged according to the Natural System, with the Synonyms of Modern Authors;* by EDWARD TATNALL. (Published by the Wilmington Institute.)—A very full and handsome Catalogue of 112 pages, including a list of expected species, and an extended catalogue of the *Diatomaceæ* and *Desmideæ* detected in that district, by Mr. C. Febiger. The addenda comprises among other things, the *Sagittaria calycina* of Engelmann. This was known only as a Western species, viz. —in Texas, Louisiana and Missouri. In the manuscript, communicated by Dr. Engelmann to the Botany of the Mexican Boundary Survey, he gave the "Merrimac River, Missouri," as a station of one variety of this species. In the proof-reading this was somehow changed into the better known "Merrimac River, Massachusetts." This error proves to be less serious than could have been expected, Mr. Swan having since detected a submerged form of this very distinct species at Kennebunk, Maine, not far north of the Merrimac. Mr. Tatnall has now found it in Delaware. A. G.

11. *Fungi Caroliniani Exsiccati: Fungi of Carolina illustrated by natural specimens of the Species;* by H. W. RAVENEL, Corresp. Memb. Acad. Nat. Sciences, &c. Fasc. I–V. Charleston, S. C., Russell & Jones,

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King st.—These fascicles are volumes, of quarto form, each containing a century of species; the specimens attached to the leaves of thick cartridge paper, with printed tickets. Each volume has an Index, and the fifth, issued last autumn, has a full index of the whole work. This induces the fear that the undertaking may not be continued farther. Much as this is to be regretted it is not surprising; for these undertakings involve a deal of labor and anxiety. The Cryptogamic *Exsiccati* of this country—as a whole perhaps unrivalled by those of any other—viz., of the *Musci* by Sullivant and Lesquereux, the *Lichenes* by Tuckermann, and the *Fungi* by Ravenel,—are all labors of love, and monuments of patience and disinterestedness; for their cost to subscribers defrays but a moiety of the cost of production. They are intended to stimulate research in these several branches of Cryptogamic Botany, and to facilitate their study. For this last purpose these *Exsiccati* are all essential, and they would be hardly less so even if proper manuals and other descriptive and illustrated works upon our lower Cryptogamia were generally obtainable. In time these desiderata will probably be supplied; but authentic specimens will always be invaluable. The former volumes of Mr. Ravenel's *Fungi* have been noticed and commended in this Journal. The fifth century is equally interesting and full. Perhaps the proof-reading of the letter-press, or the niceties of the typography have not been so heedfully attended to as could be desired; but we must not be over nice or too critical. We are truly grateful for what Mr. Ravenel has done, and hope that his strength and patience will still hold out through as many more centuries of *Fungi Caroliniani*. A. G.

12. *Uber Polyembryonie und Keimung von Cœlebogyne: ein Nachtrag zu der Abhandlung über Parthenogenesis bei Pflanzen, von* A. Braun. (Aus. Abhandl. der K. Akad. Wissenschaft. Berlin, 1859.) Berlin, 1860.—This elaborate treatise On the Multiplicity of Embryos and Germination of *Cœlebogyne*, a sequel to the Memoir on Parthenogenesis in Plants, occupies 263 quarto pages, and is illustrated by six plates. It discusses in great detail not only polyembryony, but many recondite incidental questions arising out of parthenogenesis. The principal direct, and a very curious contribution to our knowledge is, that polyembryony is common, or even general, in parthenogenesis; in other words, when embryos are produced without impregnation, they are apt to be superfluously and abnormally numerous. Thus, the seeds of *Ardisia polytoca*, figured by Prof. Braun, are stuck as full of embryos as is a pudding with plums. It would be interesting to know whether, conversely, multiplicity of embryos as it occurs in this case, and in orange seeds, where the flowers are hermaphrodite, indicates, not superfluous impregnation, but failure of impregnation,—a singular paradox. A. G.

13. *Illustrations of the Genus Carex;* by Francis Boott, M.D., Treasurer of the Linnæan Society. Part Second, Tab. 201–310. London, Wm. Pamplin, 1860, folio.—Two years ago we gave some account of the first volume of this magnificent and munificent work. We now have before us a second volume, containing one hundred and ten more plates, of an execution more uniformly excellent than before. The species illustrated are considerably less numerous than the plates, for sometimes two or three, or even four, and in two instances five folio plates are de-

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voted to the various forms of one species. American Caricologists will be delighted to find so many of our own species in this volume, such as *C. Franklinii, laxa, livida, limosa, Magellanica*, (which is *C. irrigua*,—here we think the rule of priority might have been waived), *rosea, retroflexa, bromoides, glaucescens, turgescens, Elliottii, Schweinitzii, rostrata, folliculata, subulata, Shortiana, debilis, glabra* (a new species gleaned from our old fields by Dr. Kneiskern), *retrorsa, tentaculata, Halei, squarrosa-stenolepis, Novæ-Angliæ, Emmonsii, varia, Pennsylvanica, umbellata, nigremarginita, Floridana, Richardsoni, miliacea*,—not to mention several others from further north or the far northwest. We hear that even a third volume is in a forward state of preparation, which may be laid before our Caricologists by the time they have digested the ample portion now so liberally supplied,—so rich is our author in materials, so zealous in good works. "*Carice pastus acuta*" having long foraged upon the sedges of every land, and ruminated his vast stock of materials with unwearied patience and skill, long may he still flourish to produce such noble volumes as these. A. G.

14. *A Second Century of Ferns; being Figures with brief Descriptions of one hundred new, or rare, or imperfectly known species of Ferns; from various parts of the World;* by Sir William Jackson Hooker, K.H., &c. London, 1860. William Pamplin. 8vo. Parts I and II, tab. 1–50.—The first Century of Ferns was published several years since; it consisted entirely of plates and descriptions taken from the well known *Icones Plantarum*, but the plates were not numbered to correspond with those of the *Icones*, and for this reason the work has not been generally quoted by writers on Ferns. The second *Century*, however, consists entirely of new matter, well selected, and its publication brings to light many new or obscure species. A new *Struthiopteris* (*S. orientalis*, Hook.) from Japan, figured at plate 4, and the imperfectly known *Camptosorus Sibiricus*, Rupr., (here reduced to *Scolopendrium*,) at plate 35, will especially interest the American botanist. The latter Fern differs from our common Walking-leaf "by the entire absence of lobes or auricles at the base of the frond." D. C. E.

15. *Species Filicum; being Descriptions of all known Ferns. Illustrated with Plates;* by Sir William Jackson Hooker, K.H., &c. Parts XI and XII, or vol. iii, parts III and IV. pp. 161–291, tab. 181–210.—This portion of the work is mostly taken up by the latter part of the great genus *Asplenium*, including *Darea, Athyrium, Diplazium, Anisogonium, Hemidictyum, &c.*, of authors. *Diplazium* differs from other *Asplenia* only in the double fruit-dots, a most inconstant character. *Darea* passes into *Euasplenium* through many species having the marks of both groups; and even *Athyrium*, perhaps the best defined of all, is too uncertain to be separately retained. Such genera as *Anisogonium, Hemidictyum* and *Thamnopteris*, depending only on slight differences in venation, are of course rejected, in conformity with the plan of the whole work. Of the genus, thus consolidated, 305 species are described, besides many dubious or unknown forms, which are barely enumerated. The graceful little Fern from Florida, distributed by Dr. Chapman under the names of *Aspl. Anchorita, A. verecundum*, &c., and which in his Flora is called *Aspl. myriophyllum*, Presl., is here reduced to *Aspl. rhizo-*

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phyllum, Kunze, var. *myriophyllum*. It is undoubtedly through some mistake that Milwaukee in Wisconsin is given as a station for it. *Allantodia Brunoniana*, Wall., of the East Indies, and *Actiniopteris radiata*, Link., of a wider range, follows next to *Asplenium*. The usual Index concludes the volume. The distinguished author is now arranging the Aspidioid Ferns, which, we trust, will in due time appear in the fourth volume. D. C. E.

16. *Uber einige Farngattungen;* von Dr. G. METTENIUS, Professor an der Universität zu Leipzig. Frankfort-on-Main. Heinr. Ludw. Bronner. 1857–9, 3 vols. 4to.—The first contribution (I.) contains an essay of sixteen pages on the classification of Ferns, which being in German is not accessible to the majority of those whom it would naturally interest and doubtless enlighten. The learned author carefully considers the subject of the venation of Ferns, and after studying it more deeply, perhaps, than any other Pteridologist, considers that while differences of venation are of great use in distinguishing species and sub-genera, they are too indefinite to be used as generic characters. This essay is followed by a monograph of the genus *Polypodium*, in 121 pages, in which 268 species are recognized, many of them described and illustrated by references to the numbers of distributed collections, and often by fragmentary but careful sketches of the venation, in three crowded lithographic plates. There are also given the names of a hundred or more dubious or imperfectly known species. In the index the names of not less than fifty genera of various authors are given as synonymous with parts of *Polypodium*. The species are classified mainly according to the venation and the shape of the fronds; and the whole arrangement is so simple, and yet so comprehensive, that, after a little studying of the meaning and application of the words used to distinguish sub-generic groups, one has but little difficulty in tracing an unknown species to its appropriate place in the vast genus.

The second part (pp. 158, tab. 4,) contains (II.) a monograph of *Plagiogyria*, a new genus of six species, (since reduced to *Lomaria* by Hooker,) (III.) a notice and figure of *Pteris scalaris*, Moritz, from Venezuela, showing a double involucre, similar to that known to exist in *Pt. aquilina* and its allies, and (IV.) an able monograph of *Phegopteris* and *Aspidium*, treating these genera in the same way as *Polypodium* in the first article. Of *Aspidium* there are given forty-seven generic synonyms, excluding such universally adopted genera as *Asplenium*, *Polypodium*, *Woodsia*, &c., to which some species have been incorrectly referred. The admitted species number two hundred and thirty, and there are perhaps half as many more doubtful ones.

The third part (pp. 210, tab 6,) treats in a similar way of (V.) *Cheilanthes*, and (VI.) *Asplenium*, two hundred and forty-nine species of the latter genus being recognized.

In this series of useful and comprehensive treatises "on certain Ferngenera," Professor Mettenius has followed out logically and carefully the principles he laid down at the beginning, and consequently, whatever views of the importance of venation, etc., botanists may have, all must concede to his writings a consistency as well as ability not often met with. In the identification of species Professor Mettenius has to aid him the large and

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valuable herbarium of Kunze, his predecessor at Leipzic, and has been intrusted with numerous collections from various herbaria, embracing the original specimens of various authors, as Swartz, Desvaux, Presl, &c. To these may be added many of the Ferns collected by Wilkes' Exploring Expedition, so that he will be able to identify in his future works the species described by Brackenridge in the report on the Ferns of that Expedition. D. C. E.

17. *Filices Horti Botanici Lipsiensis;* G. METTENIUS. Lips., 1856. fol. pp. 135, tab. 30.—In this work, which preceded those above-mentioned, Professor Mettenius has had an opportunity of applying his principles of classification to the whole class of Vascular Cryptogamia. *Phegopteris*, though without an indusium, is retained as a genus among the *Aspidieæ* because the stipe is continuous with the rhizoma, and not articulated as in *Polypodieæ*, and because the habit, which has nothing in common with *Polypodium* so closely resembles that of many *Aspidia*, that botanists are continually making interchanges between the two genera, as the species become better known. *Hypolepis* is regarded as *Phegopteris* with reflexed lobes, and is therefore put next to it. The suppression of the old Linnæan genus *Hemionitis* will be regretted, but its venation is all it has to distinguish it from *Gymnogramme*, to which it is here reduced. The *Acrostichea* of course give Professor Mettenius some trouble, and it is doubtful if he can eventually limit them to the five genera recognized in this work.

The book is beautifully printed, and the plates are of singular accuracy and distinctness. D. C. E.

ZOOLOGICAL NOTICES.—

18. *On the genus Peasia.*—In the Proceedings of the Zoological Society of London for 1860, page 37, plate 70, Mr. Wm. H. Pease of Honolulu has published descriptions and colored figures of five species of Planariidæ from the Sandwich Islands, supposed to form a new genus. Of these species, which are pretty well represented on the plate, the first is a *Stylochus*, the second and fifth are *Prosthiostoma*, the third a *Physanozoum*, and the fourth an *Eurylepta*. This kind of progress can scarcely benefit science. As well might one take a *Strombus*, a *Conus*, a *Cypræa* and a *Terebra*, and found upon them a new genus of shells! W. S.

19. *On the genus Bipaliura;* by WM. STIMPSON.—During the visit of the North Pacific Expedition to Hong Kong in 1854, my attention was called, by Dr. Bowring, to some remarkable vermiform animals which he had observed creeping among damp dead leaves in his garden, and which he called "ground leeches." One of these we fortunately secured, which was found upon examination to possess the following characters. The body was linear, nearly two feet in length when fully extended, and scarcely more than an eighth of an inch in breadth. The surface was slimy, like that of a slug, and of a greyish color, with two or three longitudinal black stripes above. The head was lunate, transverse to the body, with the convexity in front, and the auricles projecting laterally to a distance equalling about half the width of the body. Upon the upper surface of the head, were scattered some minute black specks, which were undoubtedly imperfect eyes (ocelli). On the inferior surface of the body there were two small apertures in the median line, the anterior one of which, at the middle of the body, was the mouth.

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The worm therefore belonged to the order Turbellaria and to the tribe of Planarians, it is undoubtedly one of the most remarkable forms, of a very distinct and peculiar genus. Upon a recent examination of the literary history of the group I find that species of the genus have been seen and described by several other observers. The following is its history.

Many years ago (1835) Dr. T. E. Gray in his "Zoological Miscellany" first described one of these animals under the name of *Planaria lunata*, from Bengal, (Zool. Misc. p. 5). The description is short, but sufficient to show unmistakably the place of the species in the genus under consideration. This description has been overlooked by all subsequent authors, and even Dr. Gray himself appears to have forgotten it, although he has undoubted priority.

In 1842 Dr. Cantor in a paper on the fauna and flora of Chusan (Ann. Mag. Nat. Hist., ix, 277) says, "Among the annelides occurs a remarkable form with the anterior part drawn out to the sides like the head of *Zygæna*. He also speaks of two other species known to him, one from Bengal. The latter is probably *Pl. lunata*.

I can find no further published mention of such forms, even in the "Systema Helminthura" of Diesing, 1851, who overlooks Gray's description,—until the appearance of my Conspectus of the Turbellaria Dendrocœla in the Proceedings of the Philadelphia Academy of Natural Sciences for February, 1857, where the genus is described under the name of *Bipalium*, which name was suggested by the resemblance of the animal, in the shape of its head, etc, to a double mattock, or pick-axe. It was placed in the family *Geoplanidæ* with the following diagnosis.

"Corpus lineare, depressiusculum. Caput discretum, lunatum, transversum; auriculis sat longis, retrorsum tendentibus. Ocelli numerosi, minuti, in capite plerumque in ejus marginibus dispositi. Os centrale vel post-centrale. Apertura genitalis inter os et extremitatem posteriorem, sepius ad dimidiam distantiæ sita."

Four species were described, all from the Japanese islands. The original species observed in China was not found named in the Synopsis, as the specimens of that species were unfortunately lost.

In 1859 the genus was renamed by Dr. Schmarda in his "Neue Wirbellose Thiere." He calls it Sphyrocephalus and gives a colored figure, and an anatomical description.

Still more recently, in the Annals and Magazine of Natural History, it has been again named by Dr. E. Percival Wright, who calls it *Dunlopea*, and describes three species. Dr. Wright, however, having only preserved specimens to examine, has misunderstood its character somewhat. He states that there are no ocelli, and has failed to perceive the genital opening.

Both Schmarda and Wright have overlooked previous labors, so that the genus now rejoices in three distinct appellations, all given within four years. Of these *Bipalium* is the earliest. Eight species are now known.

20. *The Museum of Comparative Zoölogy* in Cambridge, Mass., was dedicated with appropriate ceremonies and addresses, to the service of Science and the Commonwealth, on the 13th of November, in the presence of a large concourse of invited guests.

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IV. ASTRONOMY AND METEOROLOGY.

1. *Three more Asteroids.*—Three more of the large group of little planets between Mars and Jupiter have been discovered since Sept. 1, 1860. In consequence of a prior discovery, the one detected by Mr. Ferguson at Washington, D. C., September, 1860, and numbered 59, has been advanced to No. 60. It is proposed to call it *Titania.*

The numbering of the asteroids is in danger of becoming confused on any plan yet devised. It is scarcely possible to say what is the order of discovery in absolute time, for a planet is sometimes seen several days before its true character is determined. The exact order of numbering is of little importance, but it is desirable that the numbers once adopted should not be changed without urgent reason. The number of the second Daphne is not even yet well settled.

The 59th asteroid, (of 10th magnitude) was discovered by M. Chacornac at Paris, Sept. 12, 1860.

The 61st, named *Danäe*, (of 10–11th magnitude) was first seen Sept. 9, 1860, by Goldschmidt, but on account of his illness it was lost for several days.

The 62d named *Erato* (of 11th magnitude) was discovered by Drs. Förster and Lesser at Berlin, Sept. 14, 1860.

2. *New Comet.*—A telescopic comet was discovered October 23, 1860, by M. Temple at Marseilles. Its place, Oct. 23, $16^h\ 30^m$ m. t. Mars., was R. A. $10^h\ 4^m\ 38^s$, N. decl. 28° 27′.

3. *Further observations on the Shooting Stars of August* 9–10, 1860.

(1.) *At Chicago, Ill.*, by Mr. Francis Bradley and others.

On the evening of August 8, 1860, Mr. B. watching alone from $10^h\ 30^m$ to midnight, saw *seven* shooting stars, but the sky was much clouded.

On the night of Aug. 9 he observed alone from $11^h\ 30^m$ P. M. to 1^h A. M. of the 10th, *fifty-seven* shooting stars, 41 of which he counted during the last hour, the sky being throughout the hour much encumbered by small cumulous clouds.

On the night of Aug. 10, Mr. Bradley was assisted by Messrs. E. P. Marsh, Wm. Dickinson, Henry E. Chesbrough, and I. H. Scupham. Between 11^h P. M. of the 10th and 2^h A. M. of the 11th, they observed 384 different shooting stars, distributed as follows, viz:

11h to 12h		12h to 1h		1h to 2h	
N.E.	23	N.E.	23	NE.	15
E.	40	E.	31	E.	19
S.	26	S.	35	S.	15
S.W.	32	S.W.	35	S.W.	24
N.W.	22	N.W.	22	N.W.	22
	143		146		95

During the last hour clouds appeared and increased so much that by 2 o'clock the sky was half covered, and the watch was therefore given up. After midnight the moon also interfered to some extent. Of the whole number of meteors seen about 30 were not conformable to the usual radiant, which for the night of the 10th–11th was a circle about two degrees in diameter, whose centre was in A.R. $2^h\ 8^m$, N. P.D. 29°.

The Aurora Borealis was visible Aug. 8, 10, 12, 17, being uncommonly fine on the night of the 10th–11th.

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(2.) *Paris, France*, by M. COULVIER-GRAVIER.—This indefatigable observer has published in the Comptes Rendus of the French Academy (li, 263), a table giving the results of his observations from July 13 to Aug. 12, 1860. The mean hourly number at midnight of shooting stars Aug. 9 he finds to be 62, Aug. 10th, 54, or about ten times as large as he finds it in the middle of July.

(3.) *Rome, Italy*, by M. SECCHI.—The shooting stars observed early in the month gave a decisive maximum on the 10th of August, viz.,

9th, from 9h	to 10h 30m P.M.	50	shooting stars,	of which	8	were	very	brilliant.			
10th, "	8h 45m "	10h 30m "	124	"	"	"	25	"	"	"	
11th, "	8h 30m "	9h 30m "	25	"	"	"	5	"	"	"	

The observations at Chicago of the 10th–11th, taken with those at New Haven of the night before, show that the August meteoric display continues to agree closely in all its characteristics with the phenomenon as observed more than twenty years ago. The number of shooting stars at this epoch is at least six times the common average, increases from evening twilight to morning dawn, is about equal on the night of the 9th and the night of the 10th, and the apparent direction of nearly all is from the vicinity of the constellation Perseus. E. C. HERRICK.

4. *Shooting Stars in November*, 1860.—For a few years before and after the ever-memorable meteoric showers of November 13th, 1832, and November 13, 1833, shooting stars were unusually abundant on that calendar day. The cycle of this phenomenon being apparently about thirty-three years, there is reason to hope for its recurrence on a large scale in 1865, 1866, or 1867, and we may expect now to see some traces of its coming. At New Haven this year, the sky was unfortunately overcast during the nights of Nov. 11–12 and 12–13. The following statements show, however, that about this period the number of shooting stars was plainly above the average. The observations from Maryland indicate that, notwithstanding this is leap-year, the night of the 13th–14th is the most fertile. This confirms the supposition that the meteoric shower of November is slowly advancing into the year. If, as is highly probable, this display is the direct successor of the like displays of Oct. 26, 1202 and Oct. 30, 1366, (this Jour. [1], xl, 364,) the motion of the node of the zone or ring which furnishes these shooting stars is at the rate of three or four days in a century. E. C. H.

(1.) *Near Cape Hatteras*, lat. 35° N., long. 75°, Nov. 7, 1860.—Dr. Bronson, of New York, Prof. C. U. Shepard and daughter, counted *forty-six* meteors in two hours, from 7h to 9h P.M. They were mostly from a point to the N.E. of the zenith. The mate of the steamer Columbia said he saw an equal number the previous night when they were North of Cape Hatteras. The night of the 8th nothing unusual was seen.

(2.) *New Haven, Conn.*—Wedn. morning, Nov. 14, 1860. Sky very clear and no moon. Prof. H. A. Newton, watching alone, from 3h 15m to 4h 15m and looking to the S.E. observed *twenty-one* shooting stars. His view was limited by high buildings and other obstructions, and embraced about one fourth of the hemisphere, from the zenith down to an altitude of about 30°; the constellation Leo being in the centre of the field of view. Of the meteors seen less than a fourth part traced back would intersect in the sickle in Leo, a larger number would intersect near the zenith. None were remarkable for size or for train.

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Nov. 15. Sky very clear. Prof. H. A. Newton watching as before, during 45 minutes from $3^h\ 40^m$ to $4^h\ 25^m$, observed *fifteen* shooting stars, having the same general characteristics as those of the morning previous.

(3.) *New York City.*—November 14. Prof. A. C. Twining watched for shooting stars during one hour, from 3 A. M. to 4 A. M. His position was at an open area commanding a good view of the S. E. quarter of the sky. The atmosphere was uncommonly clear, but the glare of the street lamps doubtless interfered with the visibility of very faint meteors. During the first fifteen minutes by estimate, he observed ten meteors, eight of which had paths conformable to the radiant point of 1833, and two of which had paths not conformable. For the next half hour not a meteor was seen. At $3^h\ 45^m$ the largest of all appeared, with a long, conformable and brilliant path. After this till 4^h three non-conformable were seen, two of which shot from near the zenith. The observed number during the hour, was therefore 14, nine conformable and five unconformable. In conclusion, he remarks:—"Compared with the similar phenomena in the years following the great meteoric shower of 1833, the meteors of the present year (except the single one at $3^h\ 45^m$) were but faintly developed. Yet it was impossible not to perceive in the whole taken together at least a *symptomatic* return of the periodical display. The morning of the 13th may have been richer in the phenomena, but it was not favorable for observation."

(4.) *Montgomery Co., Md.*—Very full observations were made during the two entire nights of Nov. 12 and 13, (both clear,) under the direction of Mr. Francis Miller, principally by the students of the Stanmore School, in Montgomery Co., Md. The following table shows the number of shooting stars observed during the different hours.

			N.	S.	E.	W.	
Nov. 12,	6½ P.M.	to 7 P.M.	0	1	3	0	4
	7	" 8	5	8	5	3	21
	8	" 9	9	12	6	3	30
	9	"10	11	9	13	5	38
	10	"11	8	12	14	4	38
	11	"12	12	14	13	6	45
			N.W.	E.	S.W.		
13,	0 A.M.	" 1 A.M.	13	20	9		42
	1	" 2	10	13	6		29
	2	" 3	25	30	13		68
	3	" 4	19	23	18		60
	4	" 5	16	20	12		48
							423
			N.	S.	E.	W.	
13,	6½ P.M.	" 7 P.M.	4	3	8	6	21
	7	" 8	13	6	14	9	42
	8	" 9	8	7	13	2	30
	9	"10	6	5	12	7	30
	10	"11	10	8	19	7	44
	11	"12	7	6	12	13	38
14,	0 A.M.	" 1 A.M.	11	9	13	13	46
	1	" 2	25	18	20	20	83
	2	" 3	8	24	20	10	62
	3	" 4	7	17	12	10	46
	4	" 5	16	16	11	15	58
			115	119	154	112	500

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For the purpose of comparison, Mr. Miller with some of his scholars observed on the night of December 12, 1860, and during 3 hours and 40 minutes ending at midnight, they saw 180 different shooting stars, distributed as follows, viz:

	N.	S.	E.	W.	
8h 20m to 9h P. M.	13	8	5	4	30
9 " 10	13	8	4	9	34
10 " 11	10	30	7	9	56
11 " 12	16	15	21	8	60

It should be remembered that the season from December 6th onward a few days is one in which shooting stars are sometimes unusually numerous. (See this Jour. [1], xxxv, 361.)

(5.) *Bloomington, Ind.*—In a letter to the Editors of this Journal, Prof. Daniel Kirkwood of the Indiana State University writes as follows:

"Assisted by several members of the Senior Class, I kept an incessant watch for meteors during six hours on the night of the 12th inst. (November, 1860.) The number of observers was at no time less than five, so that the entire hemisphere was kept in view. The first to notice the appearance of a meteor announced it aloud, that it might not be counted more than once. The whole number seen was 381, as follows:

From 10h	to	11h P. M.	-	-	-	-	-	-	45
11	"	12	-	-	-	-	-	-	66
12	"	1	-	-	-	-	-	-	68
1	"	2	-	-	-	-	-	-	66
2	"	3	-	-	-	-	-	-	90
3	"	4	-	-	-	-	-	-	46
									381

About one half of those seen after one o'clock appeared to diverge from the usual point in Leo."

5. *Narrative of the American Expedition to N. W. British America, to observe the total Solar Eclipse of July 18th*, 1860; written by Wm. Ferrel, and communicated by Capt. C. H. Davis, U. S. N., Superintendent of the Nautical Almanac.—The party consisted of two assistants sent from the Nautical Almanac Office, and of Mr. S. H. Scudder, of Boston, who was sent by the Museum of Comparative Zoology to make collections in Natural History, and who was also engaged to assist in making observations on the day of the eclipse. Leaving Boston and Cambridge at different times, the members of the party met at St. Paul on the 14th of June. Engaging a passage here on Mr. Burbank's line of stages and steamboat for Fort Garry, on the Red river of the north, they left on the morning of the 16th, and after traveling four days in a northwestern direction over the beautiful and fertile, though almost entirely uninhabited, plains of Minnesota, they arrived at Georgetown, on Red river. The party remained here one day waiting for the arrival of the Anson Northrop, a boat which runs on the Red river between this place and Fort Garry, and while here, enjoyed the hospitality and kind assistance of A. H. Murray, Esqr., Chief Trader of the Hon. Hudson's Bay Company, who seemed to be much interested in science in general, and in the success of the expedition. After following the very tortuous course of Red river about 400 miles, the party arrived at Fort Garry, in British America, on the 25th of June. Calling here upon Gov. Wm.

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Mactavish, and presenting him a letter received from the late Sir George Simpson granting permission to enter the territory, the members of the party were treated by him very courteously, and received his efficient and kind advice and assistance in obtaining an outfit and supplies for their canoe voyage through lake Winnipeg and up the Saskatchewan river. He made arrangements to transport them and their baggage on a barge to the Stone Fort about twenty miles below Fort Garry, and granted them the use of a large North canoe there without charge, and also gave them a letter to Mr. Lillie in charge there, requesting him to aid them in obtaining a suitable crew, and every thing else necessary for the expedition. An old and experienced guide and five paddlers were obtained, mostly aboriginal natives of the country, and the party was ready to leave on the 28th. The remainder of the route of the expedition was down the Red river about twenty miles to the lake, through the lake to the mouth of the Saskatchewan, and then up the Saskatchewan to Cumberland House, in all about 550 miles. The country after leaving the Red river settlement, is a desolate and uninhabited wilderness, abounding in marshes and tamarac swamps, with a few limestone bluffs along the western coast of the lake. A few encampments of migratory Indians, obtaining a miserable subsistence from fishing, were the only inhabitants seen. A voyage on lake Winnipeg in a frail canoe of birch bark, when it is stormy, is considered dangerous, especially the making of traverses of ten or twelve miles, of which there are a great many, and as the party had an unusually stormy time, and a rather frail canoe heavily loaded, it was very much detained on the voyage by the wind and waves. The party was fourteen days in going the length of the lake from Red river to the mouth of the Saskatchewan, and during the whole time it was enabled to proceed only one entire day without interruption, and was obliged to spend three consecutive days and nights on a small island in the lake on account of a long continued and violent storm. On arriving at the mouth of the Saskatchewan it was found that the river was never known to be higher, and that the ascent over the rapids and up the current the whole distance to Cumberland House would be unusually difficult only a little more than four days were left; yet the party still hoped to be able to accomplish it against the time of the eclipse. The crew labored very hard in ascending the rapids, being obliged at some places to drag the canoe along close by the shore by means of ropes, taking first only one half of the baggage and then returning for the other half, and at other places to exert the utmost of their strength with long poles in getting it past high and steep bluffs and rocks projecting into the current, so that two days were spent in making the Grand Portage, and ascending some eight or ten miles of rapids near the mouth of the river. The party now despaired of being able to reach Cumberland House in time for the eclipse, but still had hopes of being able to get within the limits of total darkness. After passing through Cedar lake, the whole country for nearly a hundred miles was overflowed by the water of the river, so that the party could find no dry spot to stop upon but were obliged to cook with a fire made amongst the roots of large floating trees, and eat and sleep in the canoe. In order to get, if possible, within the limits of total darkness to ob-

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serve the eclipse, the crew were persuaded to paddle up the river for thirty-six hours without stopping for sleep or rest, but late in the evening preceding the eclipse the party had been able to get only to the mouth of Moose river, a few miles only within the limits of total darkness. It was now very cloudy and rainy, and the strength of the crew was exhausted so that the party could do no better than stop and make preparations for observing the eclipse from this point, if by chance it should be visible next morning. It was, however, still raining in the morning and continued very cloudy until after the beginning of the eclipse, so that it could not be observed. A few glimpses of the eclipse were caught nevertheless, before it became total, but for some time immediately before and after the time of totality it was completely obscured by the clouds, so that no observations of the physical phenomena which always occur at that time, could be made. Just before the time of the total eclipse the clouds suddenly became very dark, which any one not acquainted with the cause might have attributed to the sudden gathering and thickening of the clouds before a heavy shower of rain. The darkness was at no time so great that the title page of the Nautical Almanac could not be read with facility. The instant of the end of the total eclipse was determined by the observation of a sudden change in the intensity of the light, although the disc of the sun was not seen for some time afterward. There were two strata of clouds, an upper stratum with openings through which the disc of the sun was at times seen, and a lower stratum of thin scudding clouds, which served as a screen during the greater part of the time, for observing the eclipse when it was seen through the openings in the stratum above.

The following are the results of the observations made with the telescope and sextant:

Latitude of station, - - -	53°	45′	46″
Chronometer fast of local time, - -	1^h	54^m	14·1
Ending of total eclipse, - - -	18	20	53·9
Last contact, - - - - -	19	21	9·1
Last contact with large spot, - -	19	7	29·1

The party was furnished with Professor Hind's Report, and the accompanying maps, of the Assinaboine and Saskatchewan exploring expedition, which were of great advantage in enabling it to determine its rate of progress, the distance and locality of good boat harbors, &c., by a reference to the map in which all the principal bays, islands, capes, harbors, dangerous boulders, &c., seem to be accurately delineated, as well as described in the report. They were especially useful in determining the point on the river of the southern limit of total darkness of the eclipse.

In returning, the party was again much detained by stormy weather, being obliged to stop four days and nights on point Kichinashi, and was again fourteen days in traversing the lake. On arriving at Fort Garry, on the 8th of August, it was found that the Anson Northrop had stopped running on account of low water and was laid up for the season, so that the party was detained there two weeks without any means of getting away or writing home. Finally an arrangement was made with Mr. M'Kinney, who was coming through to St. Paul with

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a train of ox wagons and carts for merchandize, to take the party and its baggage with him: hence its long delay. Twenty-two days were occupied in crossing the plains from Fort Garry to St. Paul, by way of Pembina on Red river and Crow Wing on the Mississippi, 130 miles above St. Paul, so that the party were not able to get back to Cambridge before the 20th of September.

V. BOOK NOTICES.

1. *On the Impurities of Commercial Zinc, with Special Reference to the Residue insoluble in Dilute Acids, to Sulphur, and to Arsenic;* by CHARLES W. ELIOT and FRANK H. STORER. pp. 40, 4to. (From the Memoirs of the American Academy of Arts and Sciences, [N. S.,] vol. viii, p. 57).*

In the elaborate memoir before us the authors have given a detailed account of their investigation of the impurities of commercial zinc and of their endeavors to obtain precise and definite knowledge upon the subject, with which to replace the loose, inaccurate and often contradictory statements which are current in chemical literature.

Having in the first place given a very complete synopsis of the opinions which had previously been recorded, they proceed at once to describe the experiments made by themselves. In order that their results should be as general as possible they examined authentic specimens of all the commercial zincs which they were able to procure: viz., 1. *Silesian*, 2. *Vieille Montagne*, 3. *New Jersey*, 4. *Pennsylvanian*, (from Penn. and Lehigh Zinc Works at Bethlehem,) 5. *Vieille Montagne*, (such as is used at the U. S. Mint,) 6. a sample labelled *Zinc pur*, from Rousseau Frères dealers in pure chemicals at Paris, 7. of unknown origin obtained in Berlin, (Prussia),—8, 9, 10 and 11, samples of "*English* Zinc," obtained from different works in Wales.

"A qualitative examination of the residues left by these zincs when treated with dilute acids, showed that they consisted chiefly of *metallic lead*. It will appear in the sequel, that lead is the chief impurity of commercial zinc, and that the carbon, tin, copper, iron, arsenic, and other impurities found in it by previous observers, occur either in very minute quantities, or rarely, and doubtless accidentally."

The amount of lead in each of the zincs above specified was determined quantitatively with great care. The results are as follows:†

Name of Zinc.	Amount of lead in per cent.
Silesian,	1·46
Vieille Montagne,	0·292
New Jersey,	0·079
Pennsylvania,	0·000‡
Mint,	0·494
Rousseau Frères,	0·106
Berlin,	1·297

* Communicated to the Academy, May, 29th, 1860.

† For the methods of analysis followed and precautions taken, as well as for numerous other interesting details which lack of space compels us to omit, the reader is referred to the original memoir.—EDS.

‡ This zinc leaves no appreciable residue when dissolved in dilute acid.

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Name of Zinc.		Amount of lead in per cent.
English	from Wrexham,	1·192
	" Mines Royal (Neath),	0·823
	" Dillwyn & Co. (Swansea),	1·661
	" Messrs. Vivian, (")	1·516

Minute traces of *cadmium* and of *tin* were observed in several of the samples of zinc. In no case however could the sum of both these metals have amounted to one twenty-fifth of one per cent,—excepting the New Jersey Zinc which gave decided indications of tin.

No *copper* could be detected in any sample of zinc excepting that from New Jersey which contained 0·1298 per cent of this metal.

That *iron* is usually present in commercial zinc—in quantity generally less than 0·2 per cent—being derived from the moulds in which the zinc is cast, has been demonstrated by previous observers.*

Messrs. Eliot and Storer have therefore deemed it unnecessary to occupy themselves further with this impurity. They have nevertheless determined the amount of iron in several of their specimens of zinc. That from New Jersey contained 0·2088 per cent of iron.

In regard to nickel, cobalt, manganese, etc., which have been said to occur at times in zinc, the authors remark that, "the occurrence of these metals has been denied just as often as it has been asserted, but it is of course impossible to assert the universal negative, that these metals are never to be found in any spelter. * * * * Thus much may be safely asserted, however, that if nickel, cobalt, and manganese are ever to be found in commercial zinc, they occur there accidentally, exceptionally, abnormally, and in quantities hardly to be appreciated, and utterly insignificant."

"*Carbon.*—With reference to carbon as an impurity of zinc, we have attempted to determine this single point,—Does it occur in the residue insoluble in dilute acids, as has been generally believed, but never to our knowledge proved? One fact alone renders the occurrence of carbon, or of any other non-metallic substance, in this residue extremely improbable. We have observed that the residues from the Silesian, New Jersey, Rousseau Frères, Berlin, and Mint zincs are completely dissolved in perchlorid of iron, acidulated with chlorhydric acid. If carbon or silica were present in any appreciable quantity, complete solution of the residue in this reagent could not be expected. In testing the residues from our various spelters for carbon, we adopted the following process.

"From thirty to forty grammes of the zinc to be tested were dissolved in pure dilute chlorhydric acid, the black residue thoroughly washed with hot water, and, dried at a heat much below one hundred degrees (C.). The dry, grayish powder was then ground up with fused chromate of lead, and the mixture was introduced into a small bulb, blown in a tube whose diameter was not quite a centimetre. At a short distance from the bulb, this tube was drawn down to a diameter of one or two millimetres, and the extremity of the fine tube placed under lime-water in a small test-glass. The bulb was heated till the chromate of lead was fused, and if any carbon had been present in the residue, the evolved gas would have caused a cloudiness or precipitation of carbonate of lime in the lime-water. In this manner we first tested our chromate of lead by itself, and found no cloud or precipitate in the lime-water. We next inserted the smallest possible particle of carbon into the bulb with a little chromate of lead, and obtained a large distinct cloud of carbonate of lime in the lime-water in the test-glass, and in the capillary tube which delivered the gas. Having thus proved the purity of the reagent employed, and the extreme delicacy of the test, we tested in succession the residues from Silesian, Vieille Montagne, and Ber-

* Specially by Karsten in Karsten u. Dechen's *Archiv f. Mineralogie*, xvi, 623; also Dingler's *Polyt. Journ.*, lxxxvi, 193.

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lin zincs, and from the zinc of Rousseau Frères. As precisely the same result was obtained with each of these zincs, it may be stated once for all.

"On heating the mixture of residue and chromate of lead till the chromate fused there appeared in each case a very slight deposit on the upper surface of the lime-water column in the fine tube. This deposit could not have been smaller and yet been visible; it was incomparably less than that produced by the atom of carbon which was purposely introduced into a similar tube, and was undoubtedly caused by the slight dust which collected on the residues during the processes of washing and drying, and which no possible precautions could entirely avoid. It is obvious from these experiments, that the often repeated statement, that the insoluble residue from zinc treated with dilute acids is carbon, rests on no adequate foundations, and that carbon is not an invariable constituent of crude zinc, as it is of iron. But on the other hand it is impossible to assert that carbon does not sometimes occur in commercial zinc as an accidental and wholly abnormal impurity. Thus in the specimen of New Jersey zinc which we examined, there were certain small cavities lined with black, as if a bubble of some carbonaceous gas had been decomposed within them, and the residue from this zinc, when tested as above described for carbon, produced a distinct cloudiness in the lime-water, which was sufficient evidence of the presence of a trace of carbon in this spelter; but the amount of this impurity was infinitesimal, and not at all to be compared in quantity with the lead and other metallic admixtures of which the residue mainly consisted. The presence of a little copper in this zinc may perhaps be connected with the occurrence of this trace of carbon. The residues from three of the English spelters also gave distinct reactions for carbonic acid in the lime-water; but, judging from the exceedingly small cloud of carbonate of lime produced, the amount of carbon in these zincs is even less considerable than that detected in the New Jersey zinc. The other English zinc (that from the works of Messrs. Vivian) yielded but the merest trace of carbonate of lime,—a little larger deposit, perhaps, than that obtained from the Silesian, Vieille Montagne, and other zincs first experimented upon, but not more than may easily have been derived from the invisible dust which undoubtedly collected on the residue. From none of these zincs could we obtain nearly as much carbonate of lime in the test-glass as we got from the smallest possible atom of carbon heated with chromate of lead; and it is quite clear that there is never anything more than an infinitesimal amount of carbon in the considerable residue which remains when thirty or forty grammes of commercial zinc are dissolved in dilute acids.

"Against the common opinion that carbon is one of the principal impurities of zinc, we would refer to the previously quoted statement of Wackenroder, who considered carbon only an accidental and mechanical impurity, and to the exact experiments of Karsten, who endeavored to determine the carbon in Silesian zinc by decomposing chlorid of silver and chlorid of copper by zinc, but 'could find no trace of carbon in either the hard or the soft kinds of zinc.'*

"*Sulphur.*—It has been frequently stated that sulphur is a common impurity of zinc, and that it even occurs in the insoluble residue in combination with lead. We first tested the insoluble residue from Silesian zinc for sulphur, by dissolving about 30 grammes of the zinc in pure chlorhydric acid, separating the black residue, and dissolving it in pure nitric acid. It dissolved without any appreciable residue (another evidence of the non-existence of tin in this spelter), and the diluted solution gave no precipitate whatever with nitrate of baryta. With 40 grammes of Vieille Montagne zinc, we obtained precisely the same result. The Pennsylvanian zinc leaves no residue when treated with dilute acids, and is therefore free from lead, and certainly contains no carbon or sulphur which manifest themselves as an insoluble residue. The New Jersey zinc gave an exceptional result. The blackish residue, from 32 grammes of this zinc, could not be completely dissolved in boiling nitric acid. The partial solution gave no precipitate with nitrate of baryta; the undissolved portion was fused before the blowpipe with carbonate of soda free from sulphur, and gave a distinct reaction, first for sulphur, and secondly for tin. The presence of tin in this spelter has already been demonstrated, and a minute trace of sulphur must also be counted among its impurities.

* Archiv f. Mineralogie, Karsten u. Dechen, 1842, xvi, 607. Karsten also says: "I have cemented sheet zinc with coal for many days, and then melted it; but in the resulting mass of zinc I have found no trace of carbon." Ibid., 608.

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"In addition to this negative evidence, that no precipitation is produced by barium salts in the diluted nitric acid solution of the residues from the various zincs, we would adduce positive experiments to show that any compound of sulphur with a metal, which might be present in the zinc, would, in all probability, be decomposed in presence of an excess of zinc and free acid.

"Wackenroder,* in the memoir already cited, distinctly states that the black residue from zinc is sulphid of lead,—a statement at first sight sufficiently plausible, but really inconsistent with the facts of the case. When precipitated sulphid of lead is mixed with a large excess of granulated zinc (Silesian, Vieille Montagne, or Pennsylvanian), and treated with moderately dilute sulphuric or chlorhydric acid, the black sulphid soon entirely disappears, while torrents of sulphuretted hydrogen are evolved. If, after all the zinc has been completely dissolved, the insoluble residue is fused before the blowpipe with carbonate of soda free from sulphuric acid, the mass thus obtained will not blacken silver.

"If powdered galena be substituted for precipitated sulphid of lead, the same effects will be produced, though much more slowly. The sulphid of lead, therefore, suffers complete decomposition in presence of an excess of zinc and free acid, and it is of course absolutely impossible that this substance should be found in the insoluble residue.†

"The presence of sulphur in the insoluble residue from zinc is, without doubt, very rare; but it is also an unquestionable fact, that a certain amount of sulphuretted hydrogen gas is generated whenever commercial zinc is treated with dilute acids. This phenomenon has been often observed. Thus Blancard‡ remarks, 'that the sulphur often contained in commercial zinc may be shown by bringing paper wet with acetate of lead in contact with the gas developed therefrom.' Fordos and Gélis§ say, that 'the formation of this gas (sulphuretted hydrogen) can only be attributed to the partial reduction of the sulphuric acid by the nascent hydrogen.' Subsequently Jacquelain,‖ doubting this supposed reduction of sulphuric acid, attributes the production of sulphuretted hydrogen to the presence of sulphurous acid or other compounds of sulphur, with which the sulphuric acid is contaminated. Every specimen of zinc in our possession develops sulphuretted hydrogen when treated with dilute sulphuric or chlorhydric acid, as may be manifested by placing a slip of paper moistened with alkaline acetate of lead in the neck of the flask which contains the zinc and acid. But the question recurs, What is the source of the sulphur which is necessary for the generation of this gas? Is it contained in the zinc, or is it derived from the acids used in the experiment? To obtain a satisfactory solution of this problem, it is necessary to use an acid which does not contain sulphur in any form. Sulphuric acid will not answer the purposes we have in view in this experiment; for though it is undoubtedly possible to prepare sulphuric acid free from sulphurous acid, yet the doubt would still remain concerning the reduction of the sulphuric acid by the hydrogen,—a reduction not impossible at certain temperatures and in certain states of concentration. In testing for a minute trace of sulphur in zinc, it is evidently undesirable to employ a reagent which contains sulphur, in however stable a combination. Sulphuric acid being then excluded, will chlorhydric acid answer the purpose? It is easy to prepare chlorhydric acid which gives no precipitate with baryta salts, but it is very difficult to prepare this acid from common salt and sulphuric acid, so that, while containing no chlorine, it shall be absolutely free from sulphurous acid, or some lower compounds of sul-

* *Ann. der Pharm.*, 1834, x, 53.

† We have observed that the sulphids of tin and copper are also decomposed when mixed with an excess of zinc and dilute acid. The sulphid of copper was rapidly decomposed, and the residue, after all the zinc had been dissolved, yielded only a very uncertain trace of sulphur before the blowpipe. Precipitated bisulphid of tin was decomposed much less readily, and when all the zinc had disappeared, the residue gave indications of sulphur before the blowpipe. Although this might have arisen from some impurity in the tinfoil from which the sulphid was prepared, yet it was evident that the decomposition of the sulphid of tin is effected with much greater difficulty than that of the sulphids of lead and copper.

‡ Jour. de Pharmacie, 1841, p. 543, in Dingler's Polyt. Jour. 1841, lxxxii, 425.

§ Comptes Rendus, 1941, xiii, 437.

‖ Ann. de Ch. et Phys., 1843, [3,] vii, 189.

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phur. Loewenthal's* test with sesquichlorid of iron and ferricyanid of potassium will reveal the presence of such compounds of sulphur in chlorhydric acid made with the utmost care, and in other respects pure. By means of chlorine or some similar oxydizing agent, these compounds of sulphur may undoubtedly be oxydized, or at least the larger part of these admixtures may be converted into sulphuric acid; whether their last traces can be oxydized in this way is a point by no means beyond a doubt. But if the chlorhydric acid has been treated with chlorine to accomplish this oxydation, it becomes necessary to remove from the acid the excess of the oxydizing agent, for sulphuretted hydrogen would not be developed from zinc, contaminated with sulphur, by an acid which contained free chlorine, or any substance of like properties. Thus common chlorhydric acid very often contains free chlorine, and no zinc will yield with such acid anything more than a very uncertain reaction for sulphur on lead-paper. To obtain chlorhydric acid which was above suspicion, and unquestionably free from every trace of sulphur, and from every oxydizing agent which might interfere with our reaction for sulphur in zinc, we found so difficult a task, that we finally rejected this acid altogether, and resorted to the following process. A solution of chlorid of calcium, free from every trace of sulphur, was first prepared by dissolving carbonate of lime in chlorhydric acid, adding ammonia in excess to the boiling solution, filtering off the precipitated oxyds of iron and alumina, adding to the filtrate chlorid of barium, and evaporating to dryness. The residue was dissolved in distilled water, and in this solution a slight excess of chlorid of barium was present, as was proved by the precipitate produced by a solution of sulphate of lime. Oxalic acid free from sulphur was then prepared by the following process: a quantity of commercial oxalic acid was treated with enough cold water to dissolve about half of the acid taken, and the cold solution thus obtained was partially evaporated and crystallized; the mass of crystals was washed with a saturated solution of a portion of the crystals, and was finally dissolved in distilled water. In these two reagents, the chlorid of calcium and the oxalic acid, so prepared, no sulphur could be detected, either by barium salts, Loewenthal's test, or by the blowpipe reaction on silver.

"We applied to every zinc in our possession the following test for sulphur. 10 or 15 grammes of zinc were introduced into a small flask, and a portion of the solution of chlorid of calcium and of oxalic acid added thereto; hydrogen gas was freely developed, and was tested for any sulphuretted hydrogen which it might contain, by placing a slip of paper moistened with alkaline acetate of lead in the narrow neck of the flask. In every case the paper was immediately and strongly blackened, showing conclusively that every one of the following zincs contains sulphur in a quantity extremely minute, but distinctly appreciable if a sufficiently delicate test be applied:—

1. Vieille Montagne zinc (in two distinct samples).
2. Silesian zinc.
3. The United States Mint zinc.
4. Pennsylvanian zinc.
5. Rousseau Frères zinc.
6. Berlin sheet zinc.
7. Silesian zinc (subjected to Meillet's† process for purification from arsenic).
8. New Jersey zinc.
9. " " (reduced by us from the New Jersey white zinc oxyd).
10. English zinc (in four distinct samples).

"These results are not in accordance with the statements of some previous observers. Thus Karsten, in the memoir previously cited, infers that sulphur is not contained in Silesian zinc, from the fact that he obtained no precipitate in passing the gas generated by this zinc through a solution of acetate of lead. But it must be remembered, first, that we have no evidence that Karsten's acids were free from oxydizing agents, and secondly, that the reaction for sulphur on lead-paper is a more delicate test than any process of causing the gas generated to bubble through a liquid, even though the best form of apparatus be employed to secure as far as possible thorough contact of the gas with the fluid. Moreover, Karsten subsequently men-

* Jour. pr. Chem., lx, 267.
† Dingler's Polyt. Jour., 1842, lxxxiii, 205, from Jour. de Pharmacie, 1841, 625.

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tions that a delicate black precipitate is produced when the hydrogen from zinc is passed through nitrate of silver; this precipitate was probably sulphid of silver, and not metallic silver, as Karsten conjectured.

"Again, Jacquelain, in the memoir already referred to, concludes that sulphur was not contained in the specimen of French zinc which he examined, because a complete solution of the zinc in aqua regia gives no precipitate with chlorid of barium. But obviously the precipitation of sulphate of baryta in aqua regia is by no means a sufficiently delicate test for an amount of sulphur at best exceedingly minute. In the same paper, Jacquelain, criticising the observation reported by Fordos and Gélis of the generation of sulphuretted hydrogen from zinc and dilute sulphuric acid, implies that there is no sulphur in zinc by stating that the development of sulphuretted hydrogen from zinc may be avoided by using properly prepared acid. The acid which Jacquelain used had been saturated with chlorine gas, in a process of which the principal object was the purification of the sulphuric acid from sulphurous acid. That this acid occasioned no development of sulphuretted hydrogen from the zinc is not to be wondered at, but it is not to be argued from this fact, that there is no sulphur in zinc. With regard to sulphur in the zinc from New Jersey, Alger* has remarked that the New Jersey zinc ore is known to contain no sulphur; but, on the other hand, Jackson† observed the sulphuret of zinc in the mine of red oxyd of zinc in Franklin, Sussex County, New Jersey, and a simple experiment demonstrated to us the existence of sulphur in that ore. 10 or 15 grammes of the red oxyd of zinc, not entirely free from the gangue of carbonate of lime in which the ore occurs, were reduced to a fine powder, and treated with moderately dilute pure sulphuric acid. A vigorous evolution of sulphuretted hydrogen was the immediate result."

As a general result it appears therefore that in all commercial zincs metallic lead is the principal impurity: while it is gratifying to observe that the purest of all the zincs which have been analyzed by Messrs. Eliot and Storer is that manufactured at the Pennsylvania and Lehigh Zinc Works, at Bethlehem, Pennsylvania. This spelter leaves no appreciable residue when dissolved in dilute acids, and therefore contains no lead; indeed a trace of cadmium is the only impurity whose presence in the zinc the authors can confidently assert. The ore from which this spelter is made is the hydrated silicate of zinc (electric calamine), and it is not surprising that this mineral should yield zinc of singular purity, if the ore be carefully selected.

We have here purposely omitted any allusion to the valuable discussion upon the occurrence of arsenic in zinc into which the authors have been drawn, since we propose to cite their remarks upon this subject in full in a subsequent number.

2. *A Practical Treatise on Coal, Petroleum, and other distilled Oils;* by ABRAHAM GESNER, M.D., F.G.S. New York. Baillière Brothers, 1860, 8vo, pp. 134.—This book is just what it claims to be in its title, A *Practical Treatise* on the comparatively new art of producing oils for illumination and machinery from coal and its congeners. As a contribution to the recorded technology of an obscure subject it is a decided step in advance. It describes in as simple and direct terms as the inherent complexity of the subject permits, the method of preparing and purifying coal oils and the natural oils (rock oils) allied to them. The scientific chemist as well as the technical manufacturer will find these descriptions plain matter-of-fact statements, of a man thoroughly versed in the practical details and administration of his art, and much of it of a positive and valuable addition to what was previously accessible in books.

* Am. J. Sci., xlviii, 253. † Proc. Am. Association, 1850, iv, 336.

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The author recognizes the intimate relation of the manufacture of coal oils with the production in such increasing abundance of petroleum, destined to become a powerful competitor of the artificial product, for economic use. He states the number of oil wells in Western Pennsylvania and Ohio as not less than five hundred and fifty, opened or in process of boring, and yielding by estimate not less than 25,000 to 30,000 gallons daily. It is instructive in this connection to recall the fact that the natural product (petroleum) which has been well known from the earliest records of human history, should have remained comparatively useless and almost neglected until the modern art of coal oil distillation, has shown its industrial value. It is quite possible that the future historian of the industrial arts may look back on the coal oil distillation as only an episode in the history of the development of the use of petroleum.

We would not be understood however as giving to Dr. G.'s book an unqualified approval. It abounds in loose, careless statements likely to confuse and mislead his readers; such is his allusion to "Electricity" on p. 17, which he says "plays an important part in the changes which occur during distillation." It is time this force ceased to be the *pons asinorum* whenever in matters of science ignorance lacks the courage to avow its weakness. When (as on p. 59) the author says, "A number of compounds of carbon and hydrogen have been confounded with paraffine—such as methylene, ethylene, butylene," &c., he darkens council by words without knowledge. Since no one is likely to mistake these three *gaseous* products, C_2H_2, C_4H_4 and C_8H_8, the second of which, ethylene, is '*olefiant gas*' and the third is '*oil gas*,' for the beautiful white crystalline paraffine, whose formula may be as our author states, on the authority of Lewis, $C_{20}H_{21}$, or it may be $C_{48}H_{50}$. What he meant to say doubtless was that many substances termed paraffine consist of a mixture of several polymeric hydrocarbons, which form the higher terms of a series to which olefiant gas belongs—which is probably the fact.

Chemists will be curious to know the evidence on which Dr. G. rests the "Homologous series obtained from the bitumen of Trinidad," (page 86) embracing by enumeration nineteen consecutive compounds on the assumed type $C_{n+1}H_n$. Such vague assertions will neither, as he supposes, "interest the professional chemist," or extend the bounds of science. Like too many technical works printed in this country, this book abounds in typographical errors—such as the persistent use of analine for aniline.

Considering the author's well-known position as plaintiff in the case of Gesner vs. Cairnes—we esteem his allusion to the "Albert Coal" to be in bad taste, since it gives only a partizan view of a case where the testimony was very various and evenly balanced, as the printed minutes of the case from the notes of the Judge clearly show.* There are many other things in this book open to criticism which we hope will be corrected in a second edition.

3. *General Problems from the Orthographic Projections of Descriptive Geometry; with their Applications to Oblique—including Isometrical—Projections, Graphical Constructions in Spherical Trigonometry, Topographical Projection, and Graphical Transformations;* by S. EDWARD

* Report of a case tried at Albert Circuit, 1852, before his Honor Judge Wilmot and a special Jury. Abraham Gesner vs. William Cairnes, copied from the Judge's Notes. St. John, N. B., 1853. 8vo, pp. 167.

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WARREN, C.E., Professor of Descriptive Geometry and Geometrical Drawing in the Rensselaer Polytechnic Institute, Troy, N. Y., 412 pp., 8vo. New York: JOHN WILEY, 1860.—This is a more extended work than any other American treatise on Descriptive Geometry which has hitherto appeared. It is rigorously systematic and truly philosophical in its general plan, but is open to the objection of being encumbered with a complex system of divisions, and subdivisions in a descending scale, that will not be apprehended readily by the student. Notwithstanding this objection, the work is on the whole admirably adapted to secure the important educational benefits to be derived from such a study —the realization of a true mental culture, as well as the acquisition of exact knowledge. From this point of view the most striking feature is the plan of prefixing to the detailed solution of each problem, an outline sketch of the process, given without reference to a diagram, which the author terms a "Solution in Space." Another commendable feature is the thoroughness, and fullness of detail with which the more important elementary problems are worked up.

The problems relating to each of the four general classes of surfaces are arranged under four distinct heads, or "Classes of Operations;" viz: Projections, Intersections, Tangencies, and Developments. In his mode of treatment of some of these topics the author has displayed considerable originality. The doctrine of tangency especially is presented in a new light. A new definition is given of a tangent line not liable to certain plausible objections that may be urged against the definition generally adopted, and which may be more readily and more distinctly apprehended by the student, and conducts more readily to the rules for drawing tangents to special curves. But if the author desires that the definition he has given shall maintain its ground, the task devolves upon him of showing that it is completely reconcilable with the principles of geometrical analysis, and would accommodate itself to analytical as well as purely geometrical investigations.

We hail with pleasure the appearance of so comprehensive and thorough a treatise upon a branch of mathematics which holds so prominent a place in our schools of practical science, and commend it to the attention of all who are desirous of obtaining a complete knowledge of the mathematical theory of geometrical drawing.

4. *Cooke's Chemical Physics.*—A critical and complimentary notice of Prof. Cooke's elaborate and excellent work, in the London Athenæum for Nov. 17, concludes with these words:

"As an introduction to chemical physics, this is by far the most comprehensive work in our language. We only fear that it may be considered too extended for use in the class-room. We have, however, no doubt that it will find its way into the library of students who are ambitious of laying a secure foundation for their chemical knowledge."

5. SILLIMAN: Principles of Physics—2d edition. Revised and rewritten. Small 8vo, pp. 700. Philadelphia, Peck & Bliss. 1861.—This new edition varies from the first chiefly in the addition of mathematical demonstrations, and problems for exercise, and in the recomposition of nearly the whole of the first two parts—while the whole is enriched by numerous additions, designed to make it an exact and useful manual for the teacher as well as for the student.

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V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake.*—About 6 A. M., on the 17th of October, 1860, Canada and the northern United States were visited by an earthquake vibration of a more general and impressive character than any which has occurred for many years. The shock appears by the observations of Dr. Smallwood, and others, to have proceeded from the east to the west. Its point of greatest intensity was low down on the St. Lawrence. Near Rivière Ouelle and Rivière du Loup, proceeding thence with diminishing intensity as far west as Hamilton. It was generally felt throughout northern and eastern New England, and as far west as Auburn, in the State of New York. At Newark, New Jersey, it was very slight and this appears to be its extreme southerly reach. Dr. Dawson* has collected the following observations from about twenty places in Canada arranged in order of their longitudes from east to west. It will be observed that the time is earlier in eastern localities, but on comparing Bic and Belleville, nearly nine degrees apart, the difference of time will be seen to be but little less than that due to the difference of longitude. The Hamilton observation would give an earlier time, but as the shock was slight and the testimony of only one observer was recorded, there may be an error. The shock thus appears to have been nearly simultaneous throughout Canada.

Bic, 6 A. M. Three shocks at intervals of some seconds, noise continued for ten minutes.

Green Island, 6, A. M.

Rivière du Loup, 6 A. M. A series of shocks lasting nearly five minutes. A schooner off this place experienced a shock resembling that of striking on a sand-bank, and the waters of the Gulf were unusually agitated.

River Ouelle, 6.15 A. M. Very violent, damaging walls and throwing down chimneys, especially in low grounds.

Eboulements, near Murray Bay, 5.30 A. M. Violent. Five other feeble shocks in rapid succession, another at noon and another at 5 P. M. This is the only place where these latter shocks are mentioned, but the hour of the first is probably an error, as Bay St. Paul, quite near Eboulements, agrees in this respect more nearly with other places.

Bay St. Paul, 5.50 A. M. Violent shock; chimneys fell.

St. Thomas (Montmagny) 6 A. M. Two shocks.

St. Joseph de la Beauce, 6.10 A. M.

Quebec, 5.50 A. M. Several shocks, severe, especially in lower parts of the city and in the environs; but less so than at River Ouelle, &c.

Leeds, Megantic, 6.10 to 6.15 A. M.

Richmond, 5.45, A. M.

Three Rivers, about 6 A. M. Shocks felt for two minutes.

Granby, about 6 A. M.

St. Hyacinthe, 5.45 A. M. Three shocks continuing more than a minute, buildings reported damaged.

Maskinonge, 6 A. M. Shocks felt for more than a minute, supposed to be from north to south.

Montreal, 5.50. Two or three perceptible shocks, felt less on the mountain than on lower ground.

St. Martin, Isle Jesus, 5.55. At Dr. Smallwood's observatory, two distinct and smart shocks. The wave passed from east to west. Barometer 29·964 inches, temperature 40° 3, wind N. E., cloudy.

Cornwall, 6 A. M.

Prescott, 5.30 A. M.

Belleville, 5.30 A. M. One shock.

Hamilton, 4.45, A. M.

* Canadian Naturalist, Oct., 1860, 365.

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"In all or nearly all of the above places the earthquake was preceded by a rumbling noise which gradually decreased after the vibrations had passed. The difference of duration ascribed to the shocks appears to arise mainly from the circumstance that some observers include the continuance of vibration in buildings, &c., as well as that of the subterranean sound; and in this way it is probable that by some persons two or more shocks have been regarded as one.

"The observation of Dr. Smallwood that the wave proceeded from east to west, may be regarded as correct. At the same time the nearly simultaneous occurrence of the shock throughout Canada, perhaps indicates that the wave did not move horizontally but reached the surface from a great depth and at a high angle as Perrey of Dijon seems to suppose the earthquakes of Eastern America have usually done. It must however be observed that at the rate of propagation given by Mallet for earthquake waves through hard rock, which is not less than 10,000 feet per second, it is quite possible that even a horizontal wave may appear to be felt at the same instant at great distances.

"All the observers agree that the sound preceded the shock and continued after it, and that the first shock was the most violent; and it is also very generally noted that it was most severely felt on low ground and least so on rocky eminences. This last character which belongs to earthquakes generally, seems to arise from the greater resistance opposed to the vibrations by loose materials as compared with hard rocks.

"It appears from the published lists that the late earthquake is the last of at least twenty-nine that have visited Canada since its discovery by Europeans."

3. *Two New Meteorites;* by J. Lawrence Smith, (in a letter to the Editors, dated, Louisville, Ky., Nov. 19th, 1860).—There have just come into my possession, two new meteoric irons; one weighing one hundred and twelve pounds from Oldham County, near LaGrange, Ky.; the other weighing thirty-seven pounds, from Robertson county, near Coopertown, Tenn. A description of them with analyses will be given in an early number of this Journal.

OBITUARY.

J. P. Espy.—The death of Mr. Espy was announced by us in vol. xxix, p. 304; the following notice of his life was communicated by Prof. A. D. Bache, at a recent meeting of the Board of Regents of the Smithsonian Institution, and forms part of the Report for 1859, p. 108.

"James P. Espy, one of the most original and successful meteorologists of the present time, died in Cincinnati, Ohio, on the 24th of January, 1860, in the seventy-fifth year of his age, after an illness of a week, at the residence of his nephew, John Westcott.

The early career of Mr. Espy as an instructor was marked by the qualities which led to his later distinction in science. He was one of the best classical and mathematical instructors in Philadelphia, which at that day numbered Dr. Wylie, Mr. Sanderson, and Mr. Crawford among its teachers.

Impressed by the researches and writings of Dalton and of Daniell on meteorology, Mr. Espy began to observe the phenomena, and then to experiment on the facts which form the groundwork of the science. As he observed, experimented, and studied, his enthusiasm grew, and his desire to devote himself exclusively to the increase and diffusion of the science finally became so strong that he determined to give up his school, and to rely for the means of prosecuting his researches upon his slender savings and the success of his lectures, probably the most original which have ever been

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delivered on this subject. His first course was delivered before the Franklin Institute of Pennsylvania, of which he had long been an active member, and where he met kindred spirits, ready to discuss the principles or the applications of science, and prepared to extend their views over the whole horizon of physical and mechanical research. As chairman of the committee on meteorology, Mr. Espy had a large share in the organization of the complete system of meteorological observations carried on by the Institute under the auspices and within the limits of the State of Pennsylvania.

Mr. Espy's theory of storms was developed in successive memoirs in the Journal of the Franklin Institute, containing discussions of the changes of temperature, pressure, and moisture of the air, and in the direction and force of the wind and other phenomena attending remarkable storms in the United States and on the ocean adjacent to the Atlantic and Gulf Coast. Assuming great simplicity as it was developed, and founded on the established laws of physics and upon ingenious and well-directed original experiments, this theory drew general attention to itself, especially in the United States. A memoir submitted anonymously to the American Philosophical Society of Philadelphia gained for Mr. Espy the award of the Magellanic premium in the year 1836, after a discussion remarkable for ingenuity and closeness in its progress, and for the almost unanimity of its result.

Mr. Espy was eminently social in his mental habits, full of bonhommie and of enthusiasm, easily kindling into a glow by social mental action. In the meetings and free discussions in a club formed for promoting research, and especially for scrutinizing the labors of its members—and of which Sears C. Walker, Professor Henry, Henry D. Rogers, and myself were members—Mr. Espy found the mental stimulus that he needed, and the criticism which he courted, the best aids and checks on his observations, speculations, and experiments. But there was one person who had more influence upon him than all others besides, stimulating him to progress, and urging him forward in each step with a zeal which never flagged—this was his wife. Having no children to occupy her care, and being of high mental endowment and of enthusiastic temperament, she found a never-failing source of interest and gratification in watching the development of Mr. Espy's scientific ideas, the progress of his experiments, and the results of his reading and studies; the collection and collation of observations of natural phenomena in the poetical region of the storm, the tornado, and of the aurora. Mrs. Espy's mind was essentially literary and she could not aid her husband in his scientific inquiries or experimeuts: her health was delicate, and she could not assist him in his out-door observations; but she supplied what was of more importance than these aids—a genial and loving interest ever manifested in his pursuits and successes, and in his very failures. *Alere flammam* was the office of her delicate and poetical temperament. Younger than Mr. Espy, she nevertheless died several years before him, (in 1850,) leaving him to struggle alone in the decline of life without the sustaining power of her devoted and enthusiastic nature.

Having in a great degree matured his theory of storms; having made numerous inductions from observations, and having written a great deal in regard to it, Mr. Espy took the bold resolution, though past middle age, to throw himself into a new career, laying aside all ordinary employments, and devoting himself to the diffusion of the knowledge which he had collected and increased, by lecturing in the towns, villages, and cities of the United States. This proved a successful undertaking, and by its originality attracted more attention to his views than could have been obtained probably, in any other way. He soon showed remarkable power in explaining his ideas. His simplicity and clearness enabled his hearers to follow him without too great effort, and the earnestness with which he spoke out his convictions carried them away in favor of his theory. The same power which enabled him to succeed in his lecturing career procured subsequently for Mr. Espy the support and encouragement of some of the leading men in Congress, and especially in the Senate, and also in the executive departments. Their attention was arrested by the originality of his views and his warmth in presenting them, and he imparted so much of his conviction of their truth as to induce many of our statesmen and official persons to exert themselves to procure for him, under the patronage of the government, continued opportunities for study, research, and the comparison of observations. To the consistent support of his scientific friends, and particularly of the Secretary of this Institution, Mr. Espy owed also much in obtaining the opportunities of keeping in a scientific career. His reports to the Surgeon General of the army, to Congress, and to the Secretary of the Navy, are among his latest efforts in this direction.

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The earnest and deep convictions of the truth of his theory in all its parts, and his glowing enthusiasm in regard to it; perhaps, also, the age which he had reached, prevented Mr. Espy from passing beyond a certain point in its development. The same constitution of mind rendered his inductions from observation often unsafe. His views were positive and his conclusions absolute, and so was the expression of them. He was not prone to examine and re-examine premises and conclusions, but considered what had once been passed upon by his judgment as finally settled. Hence his views did not make that impression upon cooler temperaments among men of science to which they were entitled—obtaining more credit among scholars and men of general reading in our country than among scientific men and making but little progress abroad.

Feeling that his bodily vigor was failing, and that his life must soon close, the Secretary of the Smithsonian Institution induced him to re-examine the various parts of his meteorological theories of storms, tornadoes and water spouts, and to insert in his last report, while it was going through the press, an account of his most mature views. I trust that the Secretary will, in one of his reports, give us a thorough and critical examination of the works and services of this remarkable contributor to a branch of science, the knowledge of which the Smithsonian Institution has already done so much to advance and to diffuse."

On motion of Professor Bache, the following resolutions were adopted:

Resolved, That the Regents of the Smithsonian Institution have learned with deep regret the decease of James P. Espy, one of the most useful and zealous of the meteorologists co-operating with the Institution, and whose labors in both the increase and diffusion of knowledge of meteorology have merited the highest honors of science at home and have added to the reputation of our country abroad.

Resolved, That the Regents offer to the relatives of Mr. Espy their sincere condolence in the loss which they have sustained.

On motion of Mr. Pearce, it was resolved that the remarks of Professor Bache be entered in the proceedings.

David Dale Owen, well-known as a geologist and chemist, died at his residence, New Harmony, Indiana, November 13th, 1860, aged 53. Dr. Owen has been long a contributor to this Journal and was widely known and highly esteemed as an assiduous explorer and author in the wide fields of American Geology. He was born June 24th, 1807, at Braxfield House, Lanarkshire, Scotland, where his father, Robert Owen, the eminent Philanthropist, was a large Mill owner. His mother was a daughter of David Dale, once Provost of Glasgow. Dr. Owen from 1823 to 1826, was educated at the well-known establishment of Emanuel Fellenberg, at Hofwyl, Switzerland, with three of his brothers; two of whom, (Hon. Robert Dale Owen, late American Minister Plenipotentiary at Naples, and Dr. Richard Owen,) yet survive. He subsequently spent a year in Glasgow, attending the chemical instructions of Dr. Andrew Ure. In 1828, Dr. Owen accompanied his father to the United States, where some time before, the latter had purchased a part of the town of New Harmony, Ia., as a site for testing his educational and philanthropic plans; arriving at New Orleans after an eight weeks' voyage, in January, 1829. Returning to Europe, in 1831–32,—after commencing his scientific labors in America—he visited Paris for the purpose of perfecting his hand in drawing from models, having a strong natural taste for the pencil, the evidence of which is visible in his numerous original drawings and sketches in his various geological Reports. In London, he resided for the next eighteen months, following the chemical lectures of Dr. Turner and visiting the

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Museums and Geological Society. Returning to the United States, he was, in 1838, and subsequently, associated as a volunteer explorer with the late Dr. Troost, then engaged on the Geological Reconnoissance of Tennessee. He received his Medical diploma from the Ohio Medical College, in 1835, after two years' assiduous devotion to medical studies in Cincinnati. In 1837, he married Miss Caroline Neef, daughter of Joseph F. N. Neef, the former associate of Pestalozzi, in Switzerland, and later with Mr. William Maclure, in New Harmony.

Dr. Owen's responsible labors, as an explorer, commenced in 1837, when he took charge of the Geological Reconnoissance of Indiana, performing that labor chiefly on horseback in a comparatively new country. His report on the geology of Indiana, quite a small volume, was last year reprinted, by order of the Legislature of that State.

His appointment by the General Government, in 1839, to examine the mineral lands of Iowa, which it proposed to reserve from sale, resulted in a remarkable *tour de force*, by which he was able in an incredibly short space of time, with the aid of one hundred and ten persons, mostly selected among his fellow-townsmen, to examine each quarter section, (forty acres,) of a territory, 11,000 square miles in extent, and report upon it by the appointed time.* In 1848–50 he again, under the appointment of the General Government, surveyed Iowa; the Commission including also Wisconsin and Minnesota. The results of this Survey appeared in a quarto volume, in 1852, under the sanction of Congress.† This elaborate Report was illustrated by plates of fossils, some of which were 'medal-ruled' on steel, a process never before applied to the delineation of organic remains.

His Report on the Chippewa Land District of Wisconsin, was published under instructions from the United States Treasury Department, in 1849–50.‡ Soon after the completion of his second Iowa Report, he undertook the direction of the Kentucky Geological Survey, the manuscript for the fourth Report of which was sent to press only a few weeks before his death. The three elaborate volumes, already published, on the Kentucky Survey, have been previously noticed by us.§

In 1857, he undertook also the direction of the Geological Survey of Arkansas; the work in Kentucky, being so far completed, as to authorize his assuming new duties. The first volume, (8vo,) of the Arkansas Report, appeared in 1858, and the materials for a second volume, were in the printers' hands, at the time of his death; indeed he continued dictating daily, portions of this Report to within three days of his decease. He had, in 1859, accepted the offer made him by the Board of Agriculture, for the State of Indiana to direct the new Geological Survey of that State, with the understanding that the work should be performed by his brother, Dr. R. Owen, until the completion of the Arkansas Survey permitted his personal attention to that of Indiana. This work, we understand, remains in Dr. R. Owen's hands. Besides these great and responsible labors, Dr. Owen made numerous Geological examinations for individuals and Corporations. It is a great satisfaction to know that Science

* This Journal, [2,] xi, 294.
† See this Journal, [2,] xv, 296, xvi, 91.
‡ This Journal, [2,] ix, 1850.
§ This Journal, xxii, 272, xxv, 283, 447, xxix, 287.

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will have the benefit of all Dr. Owen's public labors. The second report on the Geological Survey of Arkansas is in the hands of the printer, as also the fourth volume of the Kentucky report.

He has also left a monument of his industry and success in a fine museum and laboratory, at New Harmony, completed during the last year.

The disease of which Dr. Owen died, if not induced, was greatly aggravated by the long and severe exposures and privations to which his almost constant field labors exposed him.

He sleeps in the vault, (which was also that of his own family), of WILLIAM MACLURE, the father of American Geology, already consecrated to science as the last resting place of the eminent naturalist, THOMAS SAY.

Few men have labored more harmoniously with their associates, than Dr. Owen; whose catalogue of collaborators includes, Norwood, Shumard, Meek, Swallow, Lesquereux, Peter, Litton, Elderhorst and Joseph Lesley, Jr. His Reports bear testimony to the eminent sense of justice which led him to assign to each of his associates the share both of honor and responsibility which was his due. Nor should we fail to state that his eldest son, for the last year or two, has been his professional associate and assistant. In view of his great executive and scientific ability, rich experience, and comparative age, science had much to hope for in the continued life of Dr. Owen, and his loss is great in proportion to these reasonable hopes. It will be seen from an advertisement in this Number, that the administrator of Dr. Owen's estate, offers a part of his Scientific property for public sale.

MR. S. A. CASSEDAY died the latter part of September, of "congestive chill." His papers in connection with Mr. Lyon on Crinoidea, published in this Journal, were valuable contributions to American palæontology, to which he had devoted a large share of attention. He was a native and resident of Louisville, Ky.

Bibliography; by J. NICKLÈS.

PARIS, chez MALLET-BACHELIER.

Recherches sur l'équivalent mécanique de la chaleur, par G. A. HIRN. 1 vol. in 8° d. 340 pages, avec planches.—Cet ouvrage a été couronné, par la Société de Physique de Berlin, qui avait mise au concours la question si important, de l'équivalent mécanique de la chaleur.

PARIS, chez HACHETTE, rue Pierre-Sarrazin.

Cours de Droit Naturel, par JOUFFROY. 2 vol. in 12° d. 430 pages; ouvrage essentiellement philosophique et d'une très grande portée.

En Amérique et in Europe, par MARMIER. 1 vol. 12° d. 480 pages.—Cet ouvrage qui sera sourtout lu avec intérêt par les habitans des anciennes colonies françaises, telles que le Canada, la Louisiane, etc., est la réimpression d'une série d'articles qui ont paru dans la Revue des deux Mondes. L'auteur est un voyageur fantaisiste, dont les productions littéraires sont fort en vogue en France.

La Norvège, par LOUIS ENAULT. 1 vol. in 12° d. 450 pages.—C'est un ouvrage du méme genre que le précédent et non moins estimé.

L'année scientifique et industrielle, par L. FIGUIER. 1 vol. in 12° d. 300 pages, 4me annee.—Ouvrage essentiellement populaire et exposant d'une manière succincte, les principales découvertes accomplies dans l'année dans le domaine des sciences d'observation.

L'année musicale, par SCUDO.—A l'ouvrage de M. FIGUIER vaut s'annexer l'année musicale, et—

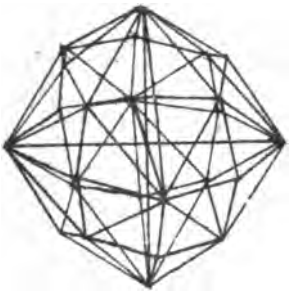
L'année littéraire et dramatique, de M. VAPPEREAU.

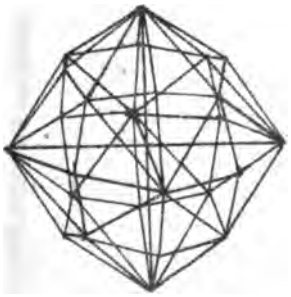
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PROCEEDINGS BOSTON SOC. NAT. HIST., continued from vol. XXX, 1860, MARCH—p. 241, (also 251.) On consecutive faunæ and their corresponding number of geological formations, as furnishing arguments against the theory of Darwin; *Prof. Agassiz.*—p. 242, Discussion on same by *Prof. Rogers;* and p. 244, rejoinder; *Agassiz.*—p. 245, On the colors of the Nacre of fresh water bivalves; *J. Lewis.*—p. 246, Views of the stratigraphical relations of deposits formed in an ocean under each of the three conditions of a *stationary*, a *subsiding*, and a *rising* position of the sea bottom; *W. B. Rogers.*—p. 249, Occurrence of so-called native Iron in Africa, (vol. v, p. 250, and vol. vi, p. 279, B. S. Proceed.) denied; *A. A. Hayes.*—p. 252, Description of new Ophiuridæ, belonging to the Smithsonian Institution and to the Museum of Comparative Zoology; *Theodore Lyman.*—p. 262, Genus *Pygorhynchus* (genus known before only fossil,) found living at Acapulco; *Agassiz.*—APRIL.—p. 271, On the distinctness of faunæ in time and space; *Prof. Agassiz.*—p. 273, Remarks, (supplementary,) on the movements of the ocean-floor; *W. B. Rogers.*—p. 274-5, discussed by *Agassiz, Rogers* and *Gould.*—p. 276, Exhibition of the albino children and a sketch of albinism, by *Dr. Kneland.*—Habits and distribution of the Gorilla and other anthropoid apes from personal observation on the West Coast of Africa; *M. Du Chaillu.*—p. 277, Table comprising the age, weight and height of 100 men from a Military Company in Boston; *Dr. B. J. Jeffries.*—MAY.—On two migratory parasites; *Prof. J. Wyman.*—p. 283, On some sub-Peat Deposits of Diatomaceæ; *A. M. Edwards*, New York.—p. 287, On the American White Ant, (*Termes frontalis, Hald.*); *S. H. Scudder.*—p. 290, On the "cocoanut pearl;" a rare calcareous concretion found in the interior of the Cocoa-nut; *Dr. J. Bacon.*—p. 293, Dissection of the poison apparatus of the Rattle Snake; *Dr. J. Wyman.*—p. 294, On the Albert Coal; *Prof. W. B. Rogers.*—p. 296, Descriptions of five new species of mammals discovered in West equatorial Africa; *P. B. Du Chaillu.*—p. 305, Analysis of juice of the leaf-stalks of common Rhubarb, [*R. rhaponticum*]; *C. T. Jackson.*—p. 305, List of the Birds of Cuba, compiled from two lists presented by D. J. Gundlach of Havana; *Dr. T. M. Brewer.*—p. 308, Notes upon the mode and plan of nidification of some of the Birds of Chili; *M. F. Germain*, of Santiago, presented by *Dr. Brewer.*—p. 306, On the foot-marks of the Connecticut River Sandstones; *Roswell Field.*—p. 317, Report on the Registering Thermometer of Dr. James Lewis; *Prof. W. B. Rogers.*—p. 319, Observations on the Geology and Palæontology of Burlington, Iowa; *C. A. White.*—Remarks on the last by Prof. *W. B. Rogers.*—p. 322, Observations by Mr. L. W. Bailey, in relation to an interesting locality of Diatomaceæ, at Oaklands, North Providence; *Prof. W. B. Rogers.*—p. 323, Descriptions of new shells collected by the United States North Pacific Exploring Expedition; *Dr. A. A. Gould.*—SEPTEMBER.—p. 345, "Report on supplying the city of Charlestown, Mass., with pure water," and on the phenomena connected with the tides at Mystic Pond; *Dr. A. A. Hayes.*—Synonymy of the species of Cyrenella, a genus of Mollusca belonging to the family of the Lucinidæ; *Temple Prime.*—p. 348, On a very fusible white mineral from Lake Superior, containing boracic acid; *Dr. A. A. Hayes.*—p. 349, Account of a recent visit to the coast of Labrador; *Dr. Henry Bryant.*—Account of a visit to some old mines in the vicinity of Franconia, N. H.; *Dr. C. T. Jackson.*—p. 350, On the fungous growth commonly called California beer seed; *Dr. White.*—Fossil skull of the Capybara; *The President.*—OCTOBER.—p. 353, On the conglomerate of Vermont; *Prof. Edward Hitchcock.*—p. 355, Letter in reference to a Canada lynx (*Lynx Canadensis*), killed in Carlisle, Mass., Sept. 9, 1860; *H. D. Thoreau.*—p. 356, Account of a recent visit to Lake Winnipeg and the Saskatchawan River; *S. H. Scudder.*—On the age of some of the sandstones of North America, generally considered as the Old Red Sandstone; *Prof. Agassiz.*—p. 357, On the black slate of Braintree, Mass., containing *Paradoxides*, and on similar strata in Newfoundland, near Lake Champlain, and in the vicinity of Quebec; *J. Marcou* (for a full report see p. 369).—NOVEMBER.—p. 358, Descriptions of ten mammals from equatorial Africa, collected by himself, and believed to be undescribed (continued); *Mr. Du Chaillu.*—p. 367, Notice of a visit to Green Island, off the mouth of Chester Bay, Nova Scotia, by the Rev. I. Ambrose, M.A., Halifax; *Dr. Bryant.*—p. 382, Descriptions of new shells collected by the North Pacific Exploring Expedition (continued); *Dr. A. A. Gould.*

For list of books received, see March Number.

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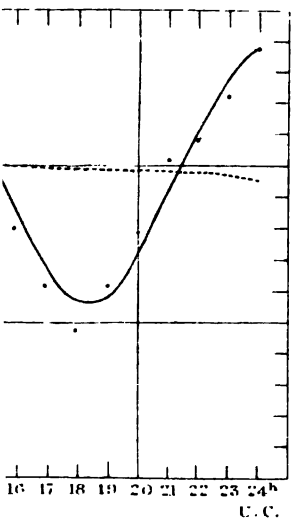


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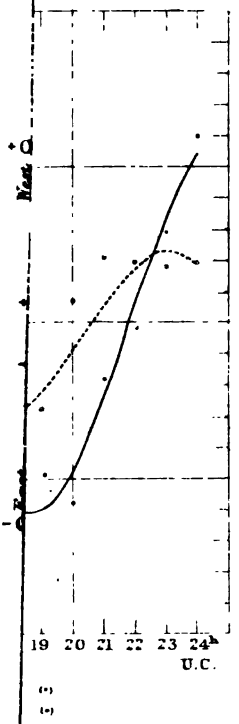


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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XIII.—*On the Appalachian Mountain System;* by ARNOLD GUYOT, Professor in the College of New Jersey, Princeton. With a map.

THE remark has been made with justice that the Appalachian or Alleghany system of mountains, although situated in the midst of a civilized, nation is still one of the chains concerning which we have the least amount of positive knowledge. This is especially true respecting the height of the culminating points of different portions of the system. A great number of measurements, have indeed been made within the last thirty years, for the construction of railroads and canals and for other practical purposes, but this net-work of surveys, it is easy to understand, has included only the basis of the system, and the lowest points at which it may be crossed. Everything not connected with practical objects has received but little attention. True, a certain number of barometrical measurements were made a long time ago, chiefly in the north; they have not, however, proved to be exact when compared with the measurements which I have lately made with greater care and under more favorable circumstances. But we must not attribute the rarity and the imperfection of mountain measurements wholly to a want of interest in science or to the absolute preponderance of the utilitarian spirit which characterizes America. It is due, in a considerable degree, to the difficulty, which has existed until within a very few years, of procuring good instruments, and to the obstacles, often very great, which the explorer meets in these wild

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regions. A chain of thirteen hundred miles in length is a vast field, especially when it includes mountains covered with interminable forests, where a footpath rarely guides the traveller's step, and which it is impossible to cross except with a hatchet in the hand and with a loss of time and strength often quite disproportionate to the results which are obtained. Add to this, that in many parts of the system, the journey is to be made in an unknown region, without a reliable map, far from a human dwelling, rarely penetrated by the most hardy hunters. The explorer must be ready to march without any trusty guide, and to sleep in the open air, exposed to the inclement temperature of the elevated regions, and obliged to depend for nourishment on the food which he can carry with him. In these circumstances the danger of perishing from exhaustion is by no means imaginary, as I know by experience.

In a great portion of the Appalachian chain, especially toward the south, the lofty forests which crown nearly all the summits, and the thick underbrush, literally impenetrable, of Rhododendrons and other evergreens, in which the faint track of the bear is often the only assistance of the traveller, are not less serious obstacles. The difficulty of obtaining general views enabling one to take his bearings in the labyrinth of mountains which cover the country, is thus considerably increased; and the favorable points of observation which are necessary to determine the position of the peaks which are measured or to be measured, and for identifying them in every case are by no means numerous. Besides all this, if the relative height of different culminating points has been determined correctly, there still remains, in order to fix their absolute height, the difficulty of determining the altitude of the points of departure or of the lower stations which are often hundreds of miles from the sea coast.

These various difficulties, or at least some of them, have diminished within the last ten years. Excellent barometers are now made in America and are within the reach of any willing observer. The railroad surveys cross all the principal sections and furnish a great number of points whose altitude is sufficiently determined to serve as a point of departure for measuring the summits throughout nearly the whole extent of the system. Moreover hypsometrical tables adapted to all the barometrical scales, partly compiled and partly computed by the writer, have been published by the Smithsonian Institution, and relieve the observer of the most tedious and time-consuming portion of his task, by reducing the computation of barometrical heights to the simplest arithmetical operation. These tables can be found in the volume of "Meteorological and Physical Tables" which, by the liberality of the Institution, is now accessible to every scientific man.

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One of my first labors, on arriving in America, in 1848, was to collect all the measurements of the Appalachian system which had then been published. Except the elevations determined for railroads and canals, nearly all the more remarkable heights which had been measured were in New England or New York, that is to say, in the White, Green and Adirondack mountains. Add to this the secondary heights measured, in considerable number, in Maine, New Hampshire and Massachusetts, a few points in Pennsylvania and Virginia, and some rather vague determinations in North Carolina, by Dr. Mitchell, and we have nearly all the hypsometrical wealth then at the service of the geographer. Massachusetts, the only state in the Union which has had a regular trigonometric survey, furnished besides some geodetic points determined with great accuracy. The same may be said of the admirable work of the Coast Survey still progressing under the skillful direction of Prof. A. D. Bache; but the points geodetically measured are seldom distant from the coast. All the other altitudes which were published had been obtained by barometric measurement.

The comparison of these last soon led me to see in the heights published by different authors such differences as indicated either a confusion of names, or errors in measurement too considerable to be attributed to the formulas employed in calculating, and which could only be attributed to imperfect instruments, or to circumstances too unfavorable for the work which was undertaken. As for detecting the error, when there was a disagreement, it was hopeless; for, since most of the authors gave merely their results, without the observations from which they were deduced, and without describing the instruments employed, or the circumstances of the measurement, a discriminating criticism was impossible. Moreover, the measurements which I had occasion to verify were nearly all found to be affected by errors more or less considerable. I was therefore led to regard them all only as approximations which by no means superseded the necessity of new determinations.

Since 1849, I have devoted my summer excursions to a study of the physical configuration of the Appalachian system, and to the barometric measurement of those points which were most important in the establishment of the laws of its relief. I began with the most remarkable culminating groups, namely, the White Mountains, where I made four excursions in as many different summers, the Green Mountains and the Adirondack. I afterwards visited in three excursions the central and southern portions of Virginia, and the vast group of elevated chains which covers the western part of North Carolina, between the boundaries of Tennessee, Georgia and South Carolina, and which form, as my observations fully show, the culminating region of the whole Appalachian system.

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I intend to continue these explorations, so far as circumstances permit, in order to collect sufficient facts for forming a just idea of the normal proportions of the system in all its parts. Meanwhile I present the list of results already obtained, hoping that this preliminary publication will afford some interest to scientific men. At the same time I desire to have it considered as a *resumé* merely of special memoirs in which I shall give the original measurements, and shall indicate the details of the work and the method employed for deducing these results. It is my wish to do my part toward establishing an usage which should be invariable among men of science, to give the elements on which are based the results, which should be in the common treasure of our knowledge. This would furnish to sound criticism the means of determining their proper value. In this particular case, however, such details may be more fitly placed in the transactions of scientific societies.

I present the following altitudes with some degree of confidence. An acquaintance of more than twenty years with the barometer, and the thousands of measurements which I have made in the Alps and elsewhere, have long ago initiated me into the theoretical and practical difficulties of the barometric method and of the instrument itself. In all measurements I have had a double object. I desired not only to obtain an accurate result, but also to perfect the barometric method. I hope I have been able to eliminate some errors and uncertainties which too commonly affect its working, and tend to throw upon the method a degree of distrust which should rather rest upon the observers themselves. At another time I may offer some further remarks upon this subject. At present I will only add that the value of the coëfficients in the formula of Laplace must be slightly modified, in accordance with the more recent determinations of the physical data which it employs, and that the corrections which depend upon the temperature and the hour of the day in which the observations are made, deserve a much closer degree of attention than has hitherto been accorded to them.

In the volume of Physical and Meteorological Tables, published by the Smithsonian Institution, I have mentioned two instances in which my barometric measurements were followed the next year by leveling with a spirit level. This occurred in the two culminating points of the Appalachian system, Mount Washington in the White Mountains of New Hampshire, and the summit of the Black Mountains in North Carolina. The received height of Mount Washington had previously been 6226 feet. My measurements in 1851 gave 6291 feet. The measurements by spirit level, by U. A. Godwin, Civil Engineer, in 1852, gave 6285 feet, and a similar leveling under the direction of the Coast Survey in 1853, gave a height of 6293 feet.

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For the Black Dome of North Carolina, the culminating point of the Black Mountains, (lately called also Mitchell's High Peak, but not the former Mount Mitchell,) my measurements in 1856 gave 6702 feet, or, by adopting the modification of the coëfficient just alluded to, 6707 feet. A measurement by spirit level in the following year, 1857, by Major J. C. Turner, Civil Engineer, who had my figures in his hand, and who set out from my point of departure, gave an altitude of 6711 feet.

To these coincidences I may add examples still more recent. Waynesville, the chief town in Haywood County, North Carolina, 27 miles from Asheville, being one of my principal stations for the measurement of all the culminating region of the Appalachian System, I determined its altitude with care by a series of hourly correspondent observations extending through several days, one at Asheville, the other at Warm Springs, thirty-seven miles below the French Broad river, near the boundary of Tennessee, the altitudes of these two points being given by the Survey of the Charleston and Cincinnati railroad which follows the valley of the French Broad, beyond the mouth of the Swannanoa. The Asheville series, in 1859, gave for the altitude of the base of the Waynesville Court House 2756 feet, assuming 2250 feet for the altitude of the Asheville Court House, according to a leveling which I was told had been executed between that point and the railroad track near the bridge of the Swannanoa. This figure of 2756 feet is that which I published early in July, 1860, in an Asheville newspaper. If I adopt the mean of the barometric measurements which I made for determining the elevation of Asheville, I find it to be 2246 feet, and Waynesville becomes 2752 feet. The series of 1860, which began at one of the benches of the railroad at Warm Springs, and which includes an intermediate station at Finescreek, gives also for Waynesville 2752 feet. But Col. Robert Love, of Waynesville, informs me that the altitude of this same point, as given to him by the Engineers of the Western North Carolina railroad, (who had just finished the location of that road,) was also 2752 feet.

I owe to the courtesy of Mr. Presstman, chief assistant of Maj. Jas. C. Turner, Chief Engineer of the road, a communication of the altitude of two other points also included in the list of published elevations, already mentioned, to wit, the summit of the route which crosses the Balsam chain at the upper end of Scott's creek, and the confluence of this creek with the Tuckaseege, twenty miles from Waynesville. In both cases, the railroad levelings agreed within a yard with the barometric measurements, these last being the highest.

These measurements, entirely independent, and proceeding from the same given points, present an argument which is well fitted to inspire confidence in barometric results obtained with fitting precautions.

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I scarcely need to add that I cannot pretend to guarantee a similar degree of accuracy in the greater number of heights measured which rest upon a single observation. All those who are acquainted with the hypsometric method fully know that, in the determinations obtained, either by the theodolite, or by the barometer, accuracy is only secured by repetitions so numerous as to permit the elimination of accidental errors incident to the variable state of the atmosphere. I may say, however, that I have taken especial precautions to avoid the two principal causes of error in barometric measurements; namely, the unequal variation, both in time and quantity, of the atmospheric pressure in the corresponding barometers, and again, the errors in the determination of the true mean temperature of the air, at the hour of observation, whether by day or by night. To prevent the first I have taken a special care to locate the corresponding barometers at stations generally distant much less than twenty, and rarely exceeding thirty miles from the points measured. As to the second, when it was not possible to eliminate the errors due to the temperature of the air, by combining observations taken both by day and by night to produce a compensation, I have resorted to the aid of tables formed from a great number of experiments to be mentioned hereafter.

That which induces me to believe that the results resting on a single observation also deserve a good degree of confidence is that having had occasion to repeat the measurement of a great number of points previously determined by careful observations, both in the Black mountains and in the county of Haywood, in different years and under different conditions of the atmosphere, the new results did not differ from those previously obtained by more than one to three yards. When the height of a mountain is known within these limits of approximation the claims of physical geography may be regarded as satisfied.

The barometers which I have employed in these different measurements are a series of Fortin barometers, modified by Delcros, and manufactured by Ernst, at Paris. These instruments, with the exception of one which is my own property, have been imported by myself under the authority of the Smithsonian Institution, for the purpose of determining by direct comparison, the relation between the standard barometer of the observatory at Paris, and the standard barometer intended for the Institution. They have been kindly left at my disposal by the Secretary, for the prosecution of these hypsometrical researches.

These instruments have been compared with the utmost care, not only before and after each excursion, but also during the progress of each, whenever there has been an opportunity. The corresponding observations have always been made with one or the other of the barometers thus compared, and their relative corrections, resulting from the equations thus established, have

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always been applied in the calculations. A long familiarity with Gay Lussac's syphon barometer, with Bunten's improvement, as well as with Fortin's cistern barometer, modified by Ernst, has convinced me that the latter is to be preferred, notwithstanding its weight and its greater length, if the utmost accuracy compatible with the method is to be sought. The variations of capillary attraction, and the soiling of the tube of the short branch of the syphon by the oxyd of mercury in the Bunten barometer are serious inconveniences. The impossibility of repairing such barometers in case they are injured in travelling, is a still more serious difficulty. I carry with each of my Fortin barometers, two extra tubes and a bottle of purified mercury which enable me in case of accident to reconstruct my barometer in two hours time, even in the depths of the wildest forest. This advantage is of the utmost value in America where every explorer must trust to himself and his own resources, unless he is willing to be constantly deprived of his instruments. It is difficult for me to think coolly of so many scientific expeditions, sent at great expense into unexplored countries, in which observations, even if made with an inferior instrument, would have had great value, but in which all barometric measurements became impossible by the fracture of the instrument at the outset of the journey. Such an excuse, under the ordinary circumstances, of an official expedition, is quite inadmissible.

Such were the considerations which led me to introduce in this country and especially recommend the modified Fortin barometer, when in 1849, '50, '51, I was charged with establishing, in the states of New York and Massachusetts, fifty meteorological stations under the scientific direction of the Smithsonian Institution. Acting in its behalf I superintended the construction of a series of meteorological instruments of which the manufacture was entrusted to a skillful optician, Mr. James Green, of New York, and which are now extensively employed throughout the United States, under the name of the Smithsonian Meteorological Instruments. I especially endeavored to render these instruments strong, simple and adjustable. By the latter phrase, I mean that their construction allows them to be regulated by a standard instrument so as to eliminate the error of zero in the thermometer, and in the barometer the total error due to capillarity and to the peculiarities in the construction of each instrument, so that they will all give immediately absolute values conformed to the same standard, and consequently comparable with one another. In the thermometer it is enough to suspend the tube to the scale by means of a screw, which permits the tube to be moved along the scale until the zero of the mercury coincides with that of the scale. In the barometer I obtain this result by means of a moveable scale which slides upon the brass casing

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of the barometric tube and which is so placed as to make its indications accord with those of the normal barometer. A line traced on the fixed scale marks the natural height of the column of mercury and makes apparent the value of the applied correction.

Each instrument made by Green, bearing a fixed number, and having been carefully compared with the standard (such, at least is the direction given) its indications may be immediately compared with those of any other of the same maker. This adjustment is evidently important for stationary observations, for it dispenses with the task of reducing by an applied correction each series of observations to a standard scale. For travelling observers and for the measurements of heights the scale of adjustments becomes of no account since it is enough to compare carefully with one another, the barometers which are employed, and to determine their equations, which otherwise are liable to vary and ought to be constantly observed anew. It is consequently better to dispense with the moveable scale, which may be disarranged by the accidents incident to a journey.

After many different experiments, and at the suggestion of Mr. Green, the cistern was modified, and instead of the two parts of the cistern screwing upon each other, a system which occasioned frequent leakage of the mercury, a means of closure by planes of contact was substituted, which not only make leakage impossible, but permit the opening and dismounting of all the parts of the cistern at any time, with the utmost ease. This construction is not only stronger, but it greatly facilitates the cleansing of the mercury, which it is well to attend to frequently. Finally it dispenses with cement and as the cistern is of injected box wood, the evil effects of extreme temperatures and of extreme moisture and dryness are avoided. Barometers of this construction are now in use throughout America, having been substituted for those of Bunten in the army meteorological stations, and having been employed in the numerous expeditions of the Pacific railroad surveys. I accordingly consider the introduction of these instruments at an epoch, when for various reasons, scientific researches were so rapidly increasing in America, as a very fortunate circumstance in enhancing the value of these same observations; for I may add that previous to this epoch, with the exception of a very few instruments imported from Europe, I scarcely found in the hands of the observers in this country a single barometer which had a scientific value.

The preceding details will not be void of interest to those who have occasion to make use of the observations recently made in America in official and other explorations. As for my own observations I would mention that they have been constantly accompanied by corresponding observations made by my young

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friends who have attended me in the various excursions, and who have studied under my direction the use of the barometer. I ought particularly to mention Mr. Ernest Sandoz, who has been with me in nearly all my excursions, and Mr. Emile Grand Pierre, who was my companion during three summers. I have also received the kind assistance of Dr. Bache, the Superintendant of the Coast Survey, who caused a series of corresponding observations for the measurement of Mt. Washington in 1851, to be made by two of his assistants, Messrs. Edward Goodfellow and B. F. West.

I would also mention Dr. Algernon Coolidge, who accompanied me to the Green Mountains, and to whom I owe, in addition to corresponding observations, the measurement of the Camel Hump. My young friends, Alexander Agassiz, Edward Rutledge, and Herbert Torrey, have given me active coöperation in the White Mountains. To my friend and fellow traveller in the Black Mountains, Rev. W. H. Green, of Princeton, I owe a number of corresponding barometric observations, and likewise a number to Prof. W. C. Kerr, of Davidson College, and to Mr. W. A. Benners, of Waynesville.

The corresponding observations, made by my companions in travel, were taken hour by hour, and sometimes even once every quarter of an hour, so as to allow the construction of a complete barometric curve which represents with great exactness the state of the barometer for any hour of the day, and renders the error of interpolation almost null.

For the purpose of distinguishing accurately the relative position of the regions explored, it may be well to describe the general structure of the system of mountains to which they belong.

The upheavals of ancient rocks which constitute this well connected physical structure, for which, as a whole, it is proper to retain the common name of the Appalachian system, extend in an undulating line thirteen hundred miles in a mean direction of N.E. to S.W., from the promontory of Gaspé upon the Gulf of St. Lawrence to Alabama, where the terminal chains sink down and are lost in the recent and almost horizontal strata of the cretaceous and tertiary formations which cover the greater portion of the surface of this state. This long range of elevations is composed of a considerable number of chains, sensibly parallel to each other, occupying more particularly the eastern part which faces the ocean, and of an extended plateau which prevails towards the west and northwest and descends gradually towards the inland valleys of the St. Lawrence, the lakes Erie and Ontario and the Ohio river.

The base on which this large belt of mountains rests, and which may be considered as bounded by the Atlantic Ocean on one side and by the Ohio and St. Lawrence rivers on the other,

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is formed, in the east, by a plain slightly inclined towards the Atlantic. The width of that plain, in New England, does not vary much from fifty miles. Near the mouth of the Hudson, however, in New Jersey, it nearly disappears, but gradually increases towards the south to a width of over two hundred miles. Its elevation above the sea, at the foot of the mountains, is in New England, from 300 to 500 feet. From the neighborhood of the bay of New York, where it is nearly on a level with the ocean, it rises gradually towards the south to an altitude of over 1000 feet. On the west the table-lands which border upon the Ohio River, and which may be considered as the general base of the system, preserve a mass-elevation of a thousand feet or more, in the thickness of which the river-bed is scooped out to the depth of from 400 to 600 feet, thus reducing the altitude of the Ohio River full one-half from that of the surrounding lands.

The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which in general, runs parallel to the inflections of its chains with remarkable regularity. This system, composed of a series of corrugations tolerably uniform, does not, like the Alps, or the other great systems of fracture, have a central or main axis, to which the secondary chains are subordinated. But it is properly compared to the system of the Jura, for it is composed like that of a series of long folds, or chains, which run parallel to each other, often with great regularity. In the same part of the system the general height of the chains is sensibly equal and their summits show neither many nor deep notches. In the middle region, especially in Pennsylvania and New Jersey, they present the appearance of long and continuous walls, the blue summits of which trace along the horizon a uniform line seldom varied by any peaks or crags. In the extreme northern and southern portions, however, this character is considerably modified. There the system loses very much of its uniformity and its physical structure becomes far more complicated; the form of simple parallel ridges almost entirely disappears.

There is one feature of the Appalachian system which distinguishes it from the ranges of the Jura; it is the well marked division into two longitudinal zones of elevation, one turned towards the shores of the Atlantic, in which the form of parallel chains just spoken of predominates, and the other turned towards the interior, which is composed of elevated and continuous plateaus, descending from the summit of their eastern escarpment, in the centre of the system, in gentle stages towards the basins of the lakes and the valley of the Ohio. Occasionally minor chains, very little elevated from their base, wrinkle the surface of the table lands. Their parallelism with those of the eastern mountainous

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zone shows that they are but the last undulations due to the action of the same forces which have upheaved and folded that region, and which have raised at the same time, the mass of these more uniform plateaus. Thus when from any point we traverse the Appalachian system from the Atlantic, we encounter first a plain more and more undulated and gradually ascending to the foot of the mountains; then a mountainous zone with its ranges parallel and its valleys longitudinal; at length a third zone of uniform plateaus slightly inclined towards the northwest, and cut with deep transverse valleys.

Another feature not less conspicuous characterizes the region of corrugations properly so-called. This is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the Great Appalachian valley. At the north it is occupied by lake Champlain and the Hudson river; in Pennsylvania it bears the name of Kittatinny or Cumberland valley. In Virginia it is the Great valley; more to the south it is called the valley of East Tennessee. At the northeast and at the centre its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley towards the southeast is the more continuous and extends without any great interruption from Vermont to Alabama. In Vermont it bears the name of Green Mountains, which it retains to the borders of New York; in the latter State it becomes the Highlands; in Pennsylvania the South Mountains; in Virginia the Blue Ridge; in North Carolina and Tennessee the Iron, Smoky, and Unaka Mountains. On the northwest of the great valley between the latter and the borders of the plateau parallel there extends a middle zone of chains separated by narrow valleys, the more continuous of which is the range which bounds the central valley. This zone has a variable breadth in different parts of the system, and the number of chains which compose it is by no means uniform throughout.

Although these features are common to the Appalachian system throughout its entire length, nevertheless it may be divided from north to south into three *divisions* which present very remarkable differences of structure. Passing the eye over the physical chart which accompanies this article we at once distinguish in the longitudinal extent of the Appalachian system two principal curvatures, the one at the north from Gaspé to New York, the concavity of which is turned towards the southeast; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the southeast; the third from New

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River to the southwest extremity of the system, the direction of which is nearly straight or forming a gentle curve concave towards the northwest. These three divisions, diminishing in extent, from the north to the south, are well marked, at the north, by the deep valleys of the Mohawk and the Hudson, which break through the Appalachian system to its base and across its entire breadth; at the south, by the New River whose deep valley with vertical walls also separates regions whose orographic characters present remarkable differences.

The *northern division* is much the most isolated; it is geologically the most ancient, since its upheavals appear coeval with the Silurian and Devonian epochs, and are thus much anterior to the rest of the system, which only emerged after the deposit of the carboniferous rocks which it has elevated. Four hundred feet more of water would separate all the vast territory of the northern division from the American continent. One hundred and forty feet would convert into an island all New England and the British possessions as far as Gaspé; for the bottom of the valley occupied by Lake Champlain and the Hudson does not in any part exceed this level.

I distinguish in this northern portion three physical regions; 1st, the triangular plateau of the Adirondack, with its mountain chains more or less parallel, between Lake Champlain and the St. Lawrence, Lake Ontario and the Mohawk: 2nd, New England, with the two swells of land separated by the deep valley of the Connecticut, and forming the base of the Green and White mountains: 3rd, the northern region, with the prolongation, towards the northeast, of the same features of relief, from the source of the Connecticut through Maine into Canada and New Brunswick to the promontory of Gaspé and the bay of Chaleurs.

The *middle or central division* extends in length about 450 miles. The eastern region, or region of folded chains, at first very narrow about New York, presents towards the centre, in Pennsylvania, its greatest breadth which again diminishes towards the south. It is composed of a considerable number of chains much curved towards the west, and remarkable for their regularity, their parallelism, their abrupt acclivities, the almost complete uniformity of their summits, and their moderate elevation, both relative and absolute, which varies from 800 and 1500 to 2500 feet. The chains, however, increase in elevation towards the south, while they become more numerous and more indented. In the Peaks of Otter, in Virginia, they attain to 4000 feet.

The western region, or the region of plateaus, is quite narrow in the southern part, but acquires towards the north the greatest breadth which it attains in any part of the Appalachian system. Its high terraces occupy all the State of New York south of the Mohawk, and a considerable part of Pennsylvania and culminate

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in the plateaus in the neighborhood of Lake Erie, where the mean altitude of the plateau reaches 2000 feet, the valleys preserving a height of 1500 feet while the hills reach 2600 feet.

This tableland forms a remarkable water-shed from which the waters descend by the Susquehanna into the valley of the Chesapeake and the Atlantic ocean, by the Genesee and St. Lawrence to the same ocean, and by the Alleghany and Ohio to the Gulf of Mexico. The Susquehanna thus starts from Lake Erie at the extreme western border of the plateau, and runs across all the Appalachian system and its mountain ranges to its eastern base. More to the southward the eastern escarpment of the plateau divides, as far as the sources of the Potomac, the waters of the Atlantic coast from those of the Gulf of Mexico. It is the same escarpment which bears the local name of Alleghany Mountain, a name which continues to be applied, south of the waters of the Potomac, to the dividing ridge along the sources of the various branches of James river, and even to the irregular hills which form a water-shed between the waters of the upper Roanoke and New River, across the Great Valley, near Christiansburg. Through all this middle region the name of Blue Ridge is applied to the main eastern chain which separates the Great valley from the Atlantic slope, and which is cut by all the rivers which flow out of it.

The *southern division*, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only 100 to 300 feet in Pennsylvania, and 500 in Virginia near James river, it is 1000 to 1200 feet in the region of the sources of the Catawba. In the interior of the mountain region the deepest valleys retain an altitude of 2000 to 2700 feet.

From the dividing line in the neighborhood of Christiansburg and the great bend of New River the orographic and hydrographic relations undergo a considerable modification. The direction of the principal parts of the system is also somewhat changed. The main chain which borders the Great valley on the east, and which more to the north, under the name of the Blue Ridge, separates it from the Atlantic plain, gradually deviates towards the southwest. A new chain detached on the east, and curving a little more to the south, takes now the name of Blue Ridge. It is this lofty chain, the altitude of which, in its more elevated groups, attains gradually to 5000 and 5900 feet, which divides in its turn the waters running to the Atlantic from those of the Mississippi. The line of separation, of the eastern and western waters, which, to this point, follows either the central chain of the Alleghanies, or the western border of the table-

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land region, passes now suddenly to the eastern chain, upon the very border of the Atlantic plain. The reason is that the terrace which forms the base of the chains, and the slope of which usually determines the general direction of the water courses, attains here its greatest elevation, and descends gradually towards the northwest. The base of the interior chain which runs alongside the Great valley is thus depressed to a lower level, and though the chain itself has an absolute elevation greater than that of the Blue Ridge, the rivers which descend from the summits of this last, flow to the northwest towards the great central valley which they only reach, in southern Virginia and North Carolina, by first passing across the high chain of the Unaka and Smoky mountains through gaps of 3000 or 4000 feet in depth.

This southern division thus presents from southeast to northwest three regions very distinct.

The first is the high mountainous region comprised between the Blue Ridge and the great chain of the Iron, Smoky, and Unaka mountains which separate North Carolina from Tennessee. It commences at the bifurcation of the two chains in Virginia, where it forms, at first, a valley of only ten to fifteen miles in breadth, in the southern part of which flows New River; it then enlarges and extends across North Carolina and into Georgia, in length more than 180 miles, varying in breadth from twenty to fifty miles. The eastern chain, or Blue Ridge, the principal water-shed, is composed of many fragments scarcely connected into a continuous and regular chain. Its direction frequently changes and forms many large curves. Its height is equally irregular. Some, groups elevated from 5000 feet and more, are separated by long intervals of depression in which are found gaps whose height is 2200 to 3700 feet, often but little above the height of the interior valleys themselves with which they are connected. The interior, or western chain, is much more continuous, more elevated, more regular in its direction and height, and increases very uniformly from 5000 to nearly 6700 feet.

The area comprised between these two main chains, from the sources of the New River and the Watauga, in the vicinity of the Grandfather Mountain, to the southern extremity of the system, is divided by transverse chains into many basins, at the bottom of each one of which runs one of those mountain tributaries of the Tennessee, which by the abundance of their waters merit the name of the true sources of that noble river.

Between the basin of the Watauga and that of the Nolechucky rises the lofty chain of the Roan and Big Yellow mountains. The northwest branch of the Black mountain and its continuation as far as the Bald mountain separate the basin of the Nolechucky from that of the French Broad river. Between the lat-

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ter and the Big Pigeon river stretches the long chain of the Pisgah and the New Found mountains. Further to the south the elevated chain of the Great Balsam mountains separates the basins of the Big Pigeon and the Tuckasegee; next comes the chain of the Cowee mountains between the latter river and the Little Tennessee. Finally the double chain of the Nantihala and Valley River mountains separates the two great basins of the Little Tennessee and the Hiwassee. The bottom of these basins preserves in the middle, an altitude of from 2000 to 2700 feet. The height of these transverse chains is greater than that of the Blue Ridge, for they are from 5000 to 6000 feet and upwards; and the gaps which cross them are as high, and often higher than those of the Blue Ridge. In these interior basins are also found groups, more or less isolated, like that of the Black mountains, which, with the Smoky mountains, present the most elevated points of the system.

Here then through an extent of more than 150 miles, the mean height of the valley from which the mountains rise is more than 2000 feet; the mountains which reach 6000 feet are counted by scores, and the loftiest peaks rise to 6700 feet; while at the north, in the group of the White mountains, the base is scarcely 1000 feet, the gaps 2000 feet, and Mount Washington, the only one which rises above 6000 feet, is still 400 feet below the height of the Black Dome of the Black Mountains. Here then in all respects is the culminating region of the vast Appalachian system.

It is worthy of notice that in the Appalachian, as in many other systems of mountains, the culminating points are situated, neither near the middle, nor in the neighborhood of what may be called its central axis, which is here the Great valley, but near the northern and southern extremities, and on the eastern side, almost outside of the system. These culminating regions seem almost exceptions to the normal structure of the system. The high mountainous region of North Carolina which has just been described is, from the bifurcation of the Blue Ridge near the great bend of the New River, an additional fold which attaches itself on the east along the principal chain which bounds the Great Valley, just as the swell, which runs along the east of the Connecticut River, upon which the group of the White mountains is situated, is an additional fold attaching itself to the east of the normal chain of the Green mountains.

The second region of this southern division is the continuation of the Great Central Valley which is divided by a general swell of the land about the sources of the Holston, into two distinct basins, the one in Virginia, narrower and more elevated, which in the basin of the New River, rises gradually towards the south from an elevation of 1600 feet to 2600 feet; the other in Tennessee, where the valley widens to nearly sixty miles between

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the Smoky mountains and the Cumberland mountains, but where it has a mean elevation of not more than about 1000 feet, that is, only one-half of the height of the neighboring valleys in the mountainous region of North Carolina.

The third region is that of the plateaus which, in Tennessee, are reduced to a table land about thirty or forty miles wide, called the Cumberland mountains on account of the abrupt edges which it presents upon the east and the west, and which give to it the appearance of a mountain chain. Further north, in Virginia, the plateaus expand and fill a vast area to the west of the Clinch and the Cumberland mountains and extend over a part of Kentucky, the central portion of which, near Lexington, preserves an altitude of more than 1000 feet.

The rapid sketch here given shows that in a hypsometrical, as well as from a geological, point of view, and even to a certain extent from its physical structure, the Appalachian system seemed to be divided into two sections of nearly equal extent; a *northern section*, which is geologically more ancient, comprehending the northern division from the mouth of the Hudson to Gaspé; and a *southern section*, which is more modern, comprising the central and southern divisions, which are bound together by more than one characteristic common to both. The separation is distinguished by a remarkable general depression of all the altitudes of the eastern zone, or parallel mountain chains, a depression which attains its lowest point in New Jersey in the parallel of New York City.

Passing from this region, where the Blue Ridge and the Kittatinny mountains are but little more than 800 or 1000 feet high, and the Great valley 50 to 150 feet, the altitude in the northern section increases rapidly, but regularly, towards the northeast, where, almost in the same parallel, lat. 44° N., we find the culminating points at Mount Washington 6288 feet high in the White Mountains, Mount Mansfield 4430 feet in the Green Mountains, and Mount Tahawus or Mount Marcy 5739 feet, in the Adirondack group. Further north the Adirondack group terminates, and the Green Mountains lose somewhat of their continuity, but show here and there, as far as Gaspé, scattered groups of mountains which still preserve an elevation of 3000 or 4000 feet.

In the southern section the altitude increases from the northeast to the southwest with the same regularity but less rapidly, and it is only towards the extremity of the system in North Carolina that they attain their maximum elevation in the Black Mountains 6700 feet, and the Smoky Mountains 6660 feet. Here, as at the north, beyond the culminating points the general altitude is but little diminished until we arrive almost to the termination of the mountains.

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The following figures demonstrate the law which I have announced above:

Upon the ridge which borders the Connecticut river on the east and where the elevation gradually increases from the sea coast until it reaches in Connecticut 1000 feet, in Massachusetts 1100 feet, and in New Hampshire 1600 feet at the sources of the Connecticut river, we meet with a series of mountains more or less isolated, which appear to have no other relation to each other than that they are placed on a common base.

The most remarkable of these, proceeding from the south towards the north are the following:

Mount Wachusett, in Massachusetts,		2018	feet high.*
Grand Monadnock, in New Hampshire,		3718	" "
Moosehillock " " "		4790	" "
Lafayette Mount, }	Group of	5290	" "
Mount Washington, }	White Mountains,	6288	" "

In the double chain of Green Mountains are the following remarkable peaks gradually increasing in height from the south to the north:

North Beacon, in the Highlands of the Hudson,	1471	feet high.
Bald Peak, in Massachusetts,	2024*	" "
Greylock, or Saddle Mount, in Massachusetts,	3505*	" "
Equinox Mount, in Vermont,	3872	" "
Killington Peak, "	4221	" "
Mansfield Mountain, "	4430	" "

North Beacon was probably measured by Capt. Partridge, the others were measured by myself.

In the Adirondack group I have cited only the most elevated point, Mount Tahawus or Mount Marcy, which is the only one of the great peaks which I have as yet measured. I found its height 5379 feet. This height differs from that of Redfield given in the Geology of the State of New York, (5467 feet), and from that of Prof. T. Benedict, (5341 feet). But it is to be remarked that the heights given by the first are all too great by reason of the defective nature of the instrument employed, as I have had occasion to convince myself; and also that Prof. Benedict, although provided with a Bunten barometer, was only able to make use of corresponding observations made at a considerable distance. From Tahawus the height of the peaks diminishes both towards the north and towards the south and the chains dwindle away before they reach Lake Champlain or the Mohawk River.

In the southern part the law of gradual increase is still more regular. It can also be exhibited at the exterior base of the mountains, along the Great valley, and in the principal chains

* Geodetic points in the triangulation of Massachusetts.

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which border it. I have already said that the interior border of the Atlantic plain rises gradually from 50 to 1200 feet, from New Jersey to the upper region of the Catawba, near Morganton. The grade of the railroads gives us in the Great valley a series of significant points:

The Great valley			at Easton, on the Delaware in Penn.,	165 ft.
"	"	"	near the Schuylkill, Penn.,	250 "
"	"	"	at Harrisburg, on the Susquehanna,	328 "
"	"	"	at Chambersburg, Penn.,	600 "
"	"	"	near Staunton, south fork of Shenandoah, in Central Virginia,	1261 "
"	"	"	at Salem, in the upper valley of the Roanoke,	1014 "
"	"	"	Newbern in the valley of New River,	2065 "
"	"	"	Mt. Airy Ridge, highest point near the sources of the Holston,	2595 "
"	"	"	Abingdon, in Southern Virginia,	2071 "
"	"	"	Bristol, on the N. boundary of Tennessee,	1678 "
"	"	"	Greenville, Tennessee,*	1581 "
"	"	"	Knoxville, "	898 "
"	"	"	Chattanooga, "	675 "

The principal chain along the eastern border of the Great valley under the name of Blue Ridge, Iron, Smoky and Unaka Mountains, presents in the same manner an increasing altitude.

Blue Ridge in New Jersey about 1000 to - -	1500	feet.
Peaks of Otter in Virginia, the highest, - - -	3993	"
White Top, on the boundary of Virginia, North Carolina, and Tennessee, - - - - - - -	5530	"
Bald Mountain, west of the Black Mountains, - -	5550	"
Smoky Dome, Clingman's Mountain, culminating point in the chain of the Smoky Mountains, - -	6660	"
Thunderhead, in Smoky Mountains, - - - -	5520	"
Great Bald, highest peak, in Smoky Mountains, near the cut of Tennessee River, - - - - -	4722	"
Hangover, highest peak of the Unaka Mountains, about	5600	"
Great Frog Mountain in Tennessee, highest peak near the south end of the System. - - - - -	4226	"

The chain which from Christiansburg takes the name of Blue Ridge and forms the barrier which separates the waters along the Atlantic plain does not appear to exceed the altitude of 4500 feet in Virginia. This is only an estimate, for I have made no measurements in this portion of the Blue Ridge. In North Carolina the culminating points are much higher, but more to the south they gradually decrease as far as Georgia.

* I am indebted to Prof. Jas. M. Safford, State Geologist of Tennessee, for a statement of the altitudes on the railroads through this State.

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Grandfather Mountain, at the sources of the Yadkin and Watauga rivers, measures	5897	feet.
The High Pinnacle, which touches the Black Mountain,	5699	"
Great Hogback, at the sources of the Tuckasegee,	4792	"
White-Side, near the sources of the Chatooga,	4931	"
Mud Creek Bald, near the head of Little Tennessee, Georgia,	4705	"
Tray Mountain, in Georgia, at the sources of Hiwassee River,	4426	"

Furthermore the transverse chains, which in North Carolina unite the two principal chains, and the interior isolated groups in which the highest summits are found, present altitudes increasing as they proceed, culminating, however, more towards the north.

Roan Mountain, High Knob, which joins the Iron mountain chain on the east,	6306	feet.
Black Dome, or Mitchell's High Peak, the culminating point of the Appalachian System,	6707	"
Richland Balsam, in Big Pigeon Valley,	6425	"
Amos Plott's Balsam, in Tuckasegee valley,	6278	"
Yellow Mountain, Cowee Chain, between the Tuckasegee and Little Tennessee valleys,	5108	"
Standing Indian, highest point in the Nantihala chain,	5518	"
Fodders' Bald, in Hiwassee valley, Georgia,	4821	"

The law of general increase of altitude towards the southwest in all parts of the Appalachian system, is thus fully established; but it is to be remarked that the different elements of which it is composed do not arrive to their maximum of altitude in the same locality nor in the same latitude. The bottom of the Great valley reaches its greatest elevation near the sources of the Holston, at about 37° N. lat. The mass elevation, or terre-plein, culminates in the vicinity of Grandfather and Big Yellow mountains. The isolated groups and intermediate chains, culminate in the Black mountains, a little south of 36° N. lat., although, in this region, the principal chains on the two sides do nowhere rise to 6000 feet; while these last, the Blue Ridge and the Smoky Mountains, reach their greatest mean and absolute height at the north of 35° N. lat., between the valleys of the French Broad and Little Tennessee, in the northern part of Haywood and Jackson counties. Although the high peaks of the Smoky mountains are some fifty feet lower than the isolated and almost exceptional group of the Black mountains, by their number, their magnitude, the continuity and general elevation of the chains, and of the base upon which they repose, they are like a massive and high citadel which is really the culminating region of all the Appalachian system.

To complete this brief review I ought to add that this increasing altitude towards the south which is so well marked in the mountain zone of the Alleghanies, is scarcely observed in the

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zone of the plateaus. A transverse section from New York to Lake Erie shows that the depression of the system does not extend to the western zone which preserves in appearance a height very nearly uniform, from the plateau of Adirondack in the State of New York as far as to the Cumberland mountains in Tennessee. There is here no well marked region of subsidence as in the eastern zone, but only a tendency to it which is slightly manifested upon a line between the maximum of eastern depression and Pittsburg. It is towards that central line of depression that the Alleghany and Monongahela rivers flow from opposite directions, thus proving the existence of inclined planes which meet about Pittsburg, forming a sort of shallow trough. North of this line the plateaus rise to the sources of the Alleghany and Susquehanna rivers, where, as was said above, they reach an altitude of over two thousand feet; still keeping, further north, on the table-land of Adirondack a mean elevation of 1500 and 1600 feet. Towards the south also the plateaus rise to the sources of the Monongahela. In Virginia and Tennessee they appear to reach 2000 or 2500 feet, at least near the mountains, but the measurements which I possess are too few in number and too uncertain to allow me to speak with certainty on this subject.

This remarkable depression of the Appalachian system in the region noticed, of which the bay of New York is the center, causes a great part of the continental plains, which form the natural base of the mountain folds, to disappear under the waters of the ocean. The waters of the tide thus come to bathe the very base of the mountains, and the region of plains fades away on the frontiers of New Jersey and New York, while towards the south the emerged portion enlarges gradually as it rises according to the law of gradual increase indicated above, so that it reaches a breadth of more than 200 miles in the Carolinas. This depression seems to be due to a local subsidence of the earth crust at an epoch, undetermined, it is true, but which must have been posterior to the principal upheaval of the Appalachian mountains. A fact, the discovery of which is due to the sagacity of Prof. J. D. Dana, seems to give weight to this opinion. He demonstrated by means of numerous soundings marked upon the excellent marine charts published by the U. S. Coast Survey, the existence of an ancient channel, a continuation of that of the Hudson river, which goes out from the bay of New York through the Narrows and advances far out under the waters of the ocean. It is not possible to suppose that such a channel which is constantly liable to be obliterated by sand banks formed by the motion of the sea, could have ever been formed in its present position. In order that the current of the river should excavate this channel it is necessary to suppose that the bottom of the sea has once occupied a higher level,

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above, or very near the surface of the ocean. The shallowness of the ocean for a considerable distance from the coast of New Jersey also indicates a prolongation of the continental plains under the sea, and the limit of the deep waters is there found at a distance nearly double that which is observed off the coast of the Carolinas. Moreover the parallelism which exists between the line of coasts and all the great general inflections of the Appalachian system, a parallelism which is well marked from Nova Scotia to Florida, here undergoes a modification which is well explained only by a local depression of this part of the system. The fact that all New Jersey is now undergoing gradual submergence from Cape May to the Bay of New York, which is proved by the numerous facts gathered by Prof. G. H. Cook in the Geological Survey of the State of New Jersey, is here not without signification.

The disposition of the relief indicated above would be readily accounted for by supposing that it is the result of a tilting motion from the north to the south, which, while depressing the northern portion below the mean altitude, elevated the southern region in the same proportion, the centre or axis of the tilt being in the vicinity of Christiansburg, near the Great Bend of the New River. As the movement affected more particularly the eastern, or mountainous belt, and not that of the plateaus of the west, the result of it was a twisting, the effect of which was to raise, in the southern part, the mass of the land on the extreme eastern border and thus to produce an inclined plane towards the northwest; while in the northern part, the general depression of the land along the Atlantic, a depression not participated in by the plateaus of the northwest, left to these latter all their altitude and produced an inclined plane from the extreme western border towards the southeast. It is then this particular disposition of these two general slopes which gives us the key of the hydrographic system of the central and southern divisions of the Appalachian mountains, which at the first glance appears so abnormal. In the central section, as has been remarked above, north of New River, the water-shed is situated along the edge of the plateaus in the Alleghany mountain proper in Virginia and Pennsylvania, from which descend the James River and the Potomac; and still further to the west in the plateaus of New York from which flow the Susquehanna and the Delaware, traversing all the chains of the mountainous region to the Atlantic. In the southern division, south of New River, the water-shed between the Atlantic and the Mississippi basin is situated upon the summit of the Blue River at the extreme eastern edge, and the numerous tributaries of the Tennessee which descend from it also traverse the whole mountainous region, but in an inverse direction, from the southeast to the northwest, and, united in the

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Great Valley at the very foot of the plateaus of the northwest, flow down by the sole channel of the Tennessee to the basin of the Mississippi.

As many of the names of mountains given below in the list of the heights measured are new, I may be allowed a few words on the subject of mountain nomenclature.

It is a mistake to suppose that names have been given to even the most prominent points in the mountains of the Appalachian system. Just in the wildest and most elevated regions, such as western North Carolina, for instance, the great majority of them have yet to be named. In a country without a regular chart, and in the midst of forests rarely visited, far from any human habitation, and in places where the primitive inhabitants have disappeared, leaving scarcely a trace of their traditions, it is not surprising that this should be the case.

The uniformity of physical configuration in a great portion of the system does not favor distinguishing different parts by specific names. Frequently people are satisfied with giving a name to a mountain range, or to a district of great extent. The observer who measures the height of definite points must do more. In order to make his labors useful, he ought to designate them individually, and determine their position so that they can always be identified, or afterwards traced upon a chart. It is, therefore, almost a matter of necessity for him to sketch such a map while proceeding, and to name, either ill or well, the points determined by his observations. A good geographic nomenclature, however, is not an easy thing; the chart of the United States proves this.

The names of objects in physical geography now in use in this country are essentially of three kinds. The Indian names which have been bequeathed to us by the aborigines, and are applied more commonly to the water courses and lakes, and especially to their towns or districts; descriptive names, as White Mountains, Black Mountains, Green Mountains, which designate entire chains or groups of mountains; and the names of men, which are applied to all. These last are the more numerous.

Wherever an Indian name is in use it ought to be preserved except where, as sometimes happens, its pronunciation is impossible for us. These names, especially in the languages of the south, are often harmonious and they are all significant, but unhappily without meaning for us. In the south they are rarely applied to mountains, although the Indian name of a river which flows near frequently extends to a neighboring chain of mountains. Indian names, designating special mountain peaks, are not common, perhaps because not preserved by the white settlers, who did not live with, but succeeded the Indian population. The more modern descriptive names have the defect of

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great similarity, for in an extent of thirteen hundred miles the topographical characters are singularly analogous. The multiplication of the same name in all parts of the system becomes here, as in political geography, a serious evil. Green, Blue, and Black mountains are found alike at the south and at the north; White mountain, White face, White side, &c., are also numerous. Chestnut, Oak, Pine mountain and Laurel mountains are found everywhere. In the South, Balsam mountains occur at every step from southern Virginia to Georgia. This name designates a mountain whose summit is covered with *Pinus Balsamifera*, or with its analogous species, *Pinus Frazeri*, which only grow on heights which exceed 5000 or 6000 feet. The Bald Mountains whose summits are destitute of forests, a thing comparatively rare at the south, are yet very numerous. It only remains for the geographer, in order to avoid intolerable confusion, to add to such names another name, or epithet, as Richland Balsam, Smoky Bald, and other similar designations.

These difficulties explain, and excuse perhaps in part, the frequent use in America of names of men to designate places, rivers, and mountains. This course requires the least effort of the imagination. A river without a name commonly takes that of the first planter who erects there his cabin or farm-house, and if there is a remarkable mountain near, it is soon designated by the same name. This is the origin of a great number of the names, more convenient than elegant, of the mountains and valleys of the Alleghanies. It is but recently, since scientific measurements have been made, that the names of men, distinguished either in the political or scientific world, have been given to prominent mountains in New England, in the state of New York and at the South.

The principles which have seemed to me proper and which have guided me in the adoption of names of mountains are to give preference to the name employed in the immediate neighborhood of the point designated. When more than one name has been given to the same point, as happens when it is seen from valleys on two different sides of the mountain, it seems proper for the observer to adopt that name which appears most natural or more euphonic. When the choice lies between the name of a man and that of a name which is descriptive and characteristic, I should choose the latter. In regard to points without established names, but recently named by scientific observers, and not by residents of the country, the right of priority ought to be respected, provided the identity of the points can be sufficiently established, a matter by no means easy, unless the positions have been determined by instruments, or otherwise, with considerable care. But it is evident that popular usage will decide in the last resort and that the name universally adopted

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will, in time, become that which geography ought to accept. When I have myself given names to mountains, I have almost always preferred a descriptive name to any other; but I acknowledge that the invention of names is a thankless and difficult task. I have, therefore, frequently had recourse to the names of neighboring rivers, or to a fortuitous circumstance, or to some little adventure, connected in my memory with this or that point to designate it, without any other object than that of distinguishing it from every other, since here as elsewhere it is better to accept almost any name rather than to leave it all in confusion.

The map which accompanies this paper was first published in Petermann's *Mittheilungen*, No. vii, 1860: it was drawn, in Gotha, with all the data at his command, by my friend and assistant Mr. E. Sandoz under the kind and skillful direction of Dr. A. Petermann, who by his admirable cartographic labors and manifold services rendered to the science of the physical globe, has long since placed himself among the most useful and scientific geographers of the day. The special map of the Black Mountain has been constructed from my own observations; the points measured having been located by means of a portable theodolite and sextant. In the map of the White Mountains the position of the points measured has been taken from the anonymous map which we owe to Prof. Bond, of Cambridge Observatory, and which was constructed from similar observations by himself. In this new edition of the general map an important correction has been made. The mountain region of North Carolina was engraved anew from a sketch founded upon my observations of 1859 and 1860. A map of that interesting region, on a larger scale, and one of the Black Mountains, showing the position of all the points measured, are in preparation and will be published, together with the discussion and results of the barometric observations, in the Smithsonian Contributions, to which I must refer for further details.

The accompanying list of heights which I have measured is classified according to physical regions. The measurements are of two kinds: those which are marked B are the heights regularly measured by the barometer; those marked P L are heights measured at a distance with a pocket level in the following manner. Wishing to measure a mountain in sight, at a moderate distance, and not exceeding in elevation the one on which I stand, I seek, with the instrument in hand, a point on a level with the summit of the mountain to be measured. Taking then at that point a barometric observation, I consider the result, corrected for the curvature of the earth and for refraction, as the height of the mountain. With an accurate level, a signal upon the mountain, and the knowledge of the exact distance a meas-

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urement thus taken would stand the same chance of accuracy as the former; with a pocket level, without a telescope, the results must be considered as approximations which may be very nearly correct, but which also may, according to the distance from which the observation was taken, vary by the height of a tree, that is to say from thirty to fifty feet. They are therefore only preliminary measurements which, while the country remains comparatively unknown, have their proper value in physical geography. I have added for reference a few points marked R R, which are elevations obtained from recent surveys for railroads, and L, which are also determined, for other purposes, by spirit-level. The chart was in part engraved before the revision of the heights given below. New measurements of points previously determined having since taken place, their results ought to have their due influence on the final values. It may happen therefore that there may be found a difference of several feet between the figures given in the table and those inscribed in the map; in those cases the figures given in the table are those which I regard as nearest to the true height. Some ancient measurements of heights in New England have been inadvertently inserted in the chart such as Wachussett 3000 instead of 2018, and some others of this sort which have been recently corrected.

The heights are given in English feet, and above mean tide-water. They are all reduced to the ground, or, for the rivers, to the level of the water.

Culminating Region of the Northern Section.

White Mountains and vicinity.

Western Slope.—Valley of the Amonoosuc.

		Height.
R.R.	Connecticut River, junction with Wells River,	407
R.R.	Bath village,	521
R.R.	Lisbon village,	577
R.R. and B.	Littleton, R. R. station,	817
R.R.	Whitefield, summit between Littleton and Lancaster,	1057
	Whitefield village,	957
R.R.	Lancaster village,	860
R.R.	Israel River, Lancaster bridge, St. Lawrence and Atlantic R. R.	849
B.	Bethlehem village,	1450
B.	Carrol house,	1428
B.	Bethlehem bridge on the Amonoosuc,	1221
P.L.	Brabrook's hotel,	1551
B.	Fabyan's Hotel (old house, now burnt),	1588
B.	Crawford Hotel (Crawford house), White Mt. Notch,	1920
B.	Franconia village, iron foundry,	921
B.	Gilmanton Hill, summit between Franconia and Littleton,	1329
B.	Franconia Valley, crossing of road to Bethlehem,	979
B.	Franconia Notch, Profile house,	1974
B.	Franconia Notch, height of land towards Franconia,	2014
B.	Echo Lake,	1926
B.	Cherry Mt., Summit road,	2192
B.	Cabin, foot of Lafayette Mt.,	1780
B.	Flume house, road front of the Hotel,	1481
B.	Thornton, road opposite the Post Office,	1223
R.R.	Plymouth R. R. station,	473

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Eastern Slope.—Valley of the Saco.

		Height.
B.	Notch of White Mts., Crawford house,	1920
B.	The Notch,	1904
B.	Willey house, road opposite the hotel,	1335
B.	Old Crawford's or Davis's hotel,	986
B.	Hart's location, Farm junction, Sawyer's River,	880
B.	Upper Bartlett's Post Office,	644
B.	Crossing of the road's junction of the Saco and Ellis River valleys,	576
B.	South Conway Post Office,	450
Δ	Pleasant Mt., east of Freyeburg, Me. (Coast Survey),	2021

Valleys of Ellis and Sawyer's Rivers.

B.	Jackson Village, hotel foot of the Falls,	771
B.	Pinkham Notch, summit near Glen Ellis Falls,	2018
B.	Junction of Carrigain Brook and Sawyers River,	1494

Northern Slope.

R.R.	Gorham, N. Hampshire, R. R. station, St. Lawrence and Atlantic R. R.,	802
L.	Glenhouse hotel,	1632
B.	Bowman's place, Summit road, between Moose and Israel Rivers,	1446
R.R.	Lowest Summit, R. R. Summit " " " " " "	1473
B.	Peabody River, crossing of path near Glenhouse,	1543
R.R.	Great Androscoggin River at Bethel station,	632
R.R.	Paris station, St. Lawrence and Atlantic R. R.,	396
R.R.	Little Androscoggin River at Danville junction,	276

Mt. Washington, the main chain or the chain of the Presidents, ascending from White Mountain Notch.

B.	Mt. Clinton,	4320
B.	Mt. Pleasant,	4764
B.	Mt. Franklin,	4904
B.	Mt. Monroe,	5384
B.	Mt. Washington, culminating point of northern section,	6288
B.	Mt. Clay,	5553
B.	Mt. Jefferson,	5714
B.	Mt. Adams,	5794
B.	Mt. Madison,	5365
B.	Lake of the Clouds, head waters of Amonoosuc River, foot of Monroe,	5009
B.	Gap between Madison and Jefferson,	4913
B.	" " Jefferson and Adams,	4939
B.	" " Adams and Clay,	4979
B.	" " Clay and Washington,	5417
B.	" " Washington and Monroe,	5100
B.	Little Monroe, W.S.W. of Monroe,	5204
B.	Gap between Franklin and Pleasant,	4400
B.	" " Pleasant and Clinton,	4050
B.	Limit of trees on Washington, N. side, and Madison,	4150
B.	Halfway house on new road, below the Steep slope,	3840
B.	Limit of trees on Clinton,	4250

Secondary chains around the main.—West of Amonoosuc River.

B.	Mt. Deception, near Fabyan's,	2449
P.L.	Cherry Mt., approximately,	3670

Chain, East of Peabody R. and Glenhouse.

P.L.	Wildcat Mt.,	4350
P.L.	Mt. Carter, South Peak,	4830
P.L.	Mt. Carter, North Peak,	4702
P.L.	Mt. Morijah,	4653
P.L.	Crawford Mt.,	3134

Chains South of the Amonoosuc River.

P.L.	Echo Mt., highest point,	3170
P.L.	The Villey, or Notch chain, the lowest or 3d N.W. peak,	4070
P.L.	Middle or highest peak, very much as Clinton by level about,	4330
P.L.	Willey Mt. proper, 1st or East peak,	4300
P.L.	Twin Mt., the highest peak,	4920

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South side, between Saco Valley and Merrimac River.

		Height.
B.	Carrigain Mt.,	4678
B.	Summit of Eastern Spur,	4419
P.L.	Brick house Mt., in the line N.E. 2 miles from Carrigain,	3850
P.L.	Pemigewassett Peak,	4420
P.L.	Tremont Mt.,	3398
P.L.	Green's Cliff,	2958
P.L.	Table Mt., 3 miles S.S.E. of Hart's ledge,	3305
P.L.	Sandwich Dome, above Campton,	3969
P.L.	Mad River peak, head of Mad River,	4397
P.L.	Whiteface, N.E. peak, the highest,	4080
P.L.	Tripyramid, N.W. of Whiteface, S. of Carrigain,	4086
P.L.	Chicorua, highest peak south,	3540

Group of Franconia Mts.

P.L.	Eagle Cliff, facing the Profile house,	3446
B.	Eagle head, near the pond,	4216
B.	Eagle pond, foot of last peak,	4170
B.	Lafayette or Great Haystack,	5290
B.	" " " South peak,	5101
P.L.	Summit of Blue or Bog-Eddy Mt., the highest part of the chain of Cannon, Kinsman and Blue Mt.,	4370
P.L.	Kinsman Mt. about	4200
B.	Cannon Mt., the prospect, appr.,	3850

West and South of the White Mts.

B.	Moose hillock, highest peak north,	4790
P.L.	Carr's Mt., highest summit,	3480
P.L.	Owl's head,	2950
P.L.	Webster side, south side of the R. R. opposite,	2310
B.	Highest farm foot of Moose hillock S.,	1631
R.R.	Warren Village,	736
R.R.	Summit of Road,	1063
R.R.	East Haverhill,	773
R.R.	Woodville R. R. station opposite Wells' River,	443
R.R.	Connecticut low water, " " "	407
R.R.	Rumney R. R. station,	520
R.R.	Plymouth village, R. R. station,	473
R.R.	Meredith Village,	542
R.R.	Concord, N. Hampshire, R. R. station,	237

Redhill and Winnipeseogee Lake.

R.R. and Canal.	Lake Winnipeseogee, mean level,	501
B.	Senter house at Centre Harbor, Lake Winnipeseogee,	553
B.	Eastern summit of Redhill,	1769
B.	Western summit " "	2025

GREEN MOUNTAINS.

B.	Manchester R. R. station,	713
B.	" Village courthouse,	864
B.	Equinox Mt., highest peak,	3872
R.R.	Rutland R.R. station,	530
B.	Herrick Mt., near Rutland,	2692
B.	Shrewsbury Peak,	3845
B.	Pico Mt., north of Killington,	3954
B.	Killington Peak,	4221
R.R.	Waterbury R. R. station,	425
P.L.	Hogback Mt.,	3648
B.	Stowe Village, foot of Mansfield Mt.;	700
B.	Mansfield Mt., the Nose,	4094
B.	Mansfield Mt., the Chin, highest,	4430
P.L.	Sterling Chain,	3700
B.	Camel Hump,	4088
P.L.	Lincoln Mt.,	4078

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PLATEAU AND MOUNTAINS OF ADIRONDACK.

Profile from Lake Champlain to Mt. Tahawus from E. to W. by N.

		Height.
L.	Lake Champlain, mean level,	96
B.	Crown Point tavern,	206
B.	Bradford farm, road summit,	695
B.	Amyhill summit road,	844
B.	Buckhollow, hamlet water of Putnam Creek,	719
B.	Penfield, water of Putnam Creek,	910
B.	Height of land dividing the Hudson and St. Lawrence waters,	1199
B.	Hammond's furnace,	1132
B.	Paradox Creek at Hammond's saw-mill,	911
B.	" " " crossing of road from Paradox Lake to Root's,	873
B.	Summit of road between Paradox crossing and Johnson's pond,	1256
B.	Johnson's pond,	964
B.	Summit of road between Johnson's pond and Root's in Schroon valley,	1262
B.	Root's farm, ground, in Schroon Valley,	842
B.	Sturtevant's mill on Mud creek,	1113
B.	Mudpond creek,	1206
B.	Summit of road between Mud creek, crossing of French's,	2013
B.	French's farm, road before,	1902
B.	Grand Boreas river, bridge,	1736
B.	Summit road, west of Boreas river,	1935
B.	Lake Sanford at Millpond,	1731
B.	Adirondack Village, or McIntyre's iron-works, hotel,	1785
B.	Summit above Beaver Marsh,	2782
B.	Lake Colden,	2736
B.	Hudson River, Great Bend,	3264
B.	Limit of trees on Mt. Marcy and Whiteface,	4851
B.	Mt. Tahawus or Mt. Marcy,	5379
L.	Lake Henderson,	1839
L.	Head of Falls,	2550
L.	Surface of Beaver marsh,	2677
L.	Summit above Beaver marsh,	2762
L.	Surface of opalescent River (Hudson),	2744

These last five altitudes are derived from levels above Lake Sandford taken by Prof. E. N. Horsford.

CULMINATING REGION OF THE SOUTHERN SECTION.

THE BLACK MOUNTAINS AND VICINITY.

Valley of the Swananoa.

R.R.	Junction of Flat Creek with Swananoa River,	2250
B.	Joseph Stepp's house,	2360
B.	Burnett's house,	2423
B.	Lower Mountain house, Jesse Stepp's house, floor of Piazza,	2770
B.	W. Patton's cabin, end of carriage road,	3244
B.	Resting place, brook behind last,	3955
B.	Upper Mountain house,	5246
B.	Passage, main branch of Swannanoa above Stepp's ascending to Toe River Gap,	3902

In the Blue Ridge.

B.	Toe River Gap, between Potatoe Top and High Pinnacle,	5188
B.	High Pinnacle of Blue Ridge,	5701
B.	Rocky Knobs, south peak,	5306
B.	Big Spring on Rocky Knobs,	5080
B.	Greybeard,	5446

Craggy Chain.

B.	Big Craggy,	6090
B.	Bull's Head,	5985
B.	Craggy Pinnacle,	5945

The Black Mountain, main chain.

B.	Potatoe Top,	6393
B.	Mt. Mitchell,	6382
B.	Mt. Gibbs,	6591
B.	Stepp's Gap, the cabin,	6103

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		Height.
B.	Mt. Hallback (or Sugarloaf),	6403
B.	Black Dome (or Mitchell's high peak, or Clingmann of State map),	6707
B.	Dome Gap,	6353
B.	Balsam Cone (Guyot of State map),	6671
B.	Hairy Bear,	6610
B.	Bear Gap,	6284
B.	Black Brother (Sandoz of State map),	6619
B.	Cattail Peak,	6611
B.	Rocky Trail Gap,	6383
B.	Rocky Trail Peak,	6488
B.	Cattail Gap,	5720
B.	Deer Mt., North Point,	6233
B.	Long Ridge, South Point,	6208
B.	" " Middle Point,	6259
B.	" " North Point,	6248
B.	Bowlen's Pyramid North End,	6348
	The Black Mountain, Northwestern Chain.	
B.	Blackstock Knob,	6380
B.	Yeates's Knob,	5975
B.	Cock's Comb,	5426
	Caney River Valley.	
B.	Green ponds at Th. Wilson's, highest house,	3222
B.	Th. Wilson's new house,	3110
B.	Wheelers' opposite Big Ivy Gap,	2942
B.	Cattail fork Junction with Caney River,	2878
B.	Sandofer Gap or low Gap, Summit of Road,	3176
B.	Burnsville, courtsquare,	2840
B.	Green Mountain near Burnsville, highest point,	4340
	Group of the Roan Mountain.	
B.	Summit of Road from Burnsville to Toe River,	3139
B.	Toe River ford on the Road from Burnsville to the Roan Mountain,	2131
B.	Baily's farm,	2379
B.	Brigg's house foot of Roan Mt., Valley of Little Rock creek,	2757
P.L.	Yellow Spot above Brigg's,	5158
P.L.	Little yellow Mount, highest,	5195
B.	The cold spring summit of Roan,	6132
P.L.	Grassy Ridge Ball N.E. continuation of Roan Mt.,	6230
B.	Roan high Bluff,	6296
B.	Roan high Knob,	6306
	From Burnsville to Grandfather Mountain.	
B.	South Toe River Ford,	2532
B.	Toe River; ford near Autrey's,	2547
B.	North-Toe River ford, below Childsville,	2652
B.	Blue Ridge, head of Brushy creek,	3425
B.	Linville river ford below head of Brushy creek,	3297
B.	Linville River at Piercy's,	3607
B.	Headwaters of Linville and Watauga River, foot of Grandfather Mt.	4100
B.	Grandfather Mt. summit,	5897
B.	Watauga River at Schull's millpond,	2917
B.	Taylorsville, Tennessee,	2395
B.	White Top, Virginia, corner of Tenn. and N. Car.	5530
	From Burnsville to the Bald Mt.	
B.	Sampson's Gap,	4180
B.	Egypt cove at Proffitts,	3320
B.	Wolfs' camp Gap,	4389
B.	Bald Mt. summit of highest peak,	5580

These four points computed by me from observations made by Prof. W. C. Kerr of Davidson College.

	Valley of the Big Ivy Creek.	
B.	Dillingham's house, below Yeates' Knob, or Big Butte,	2968
B.	Junction of the three forks of Big Ivy,	2276
B.	Salomon Carter's house,	2215
B.	Stockville, at Squire Black Stocks',	2216
R.R.	Mouth of Ivy River, by Railroad survey,	1684

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REGION OF THE GREAT BALSAM MOUNTAINS.

From Asheville to Mt. Pisgah.

		Height.
B.	Asheville courthouse,	2250
B.	Sulphur springs, the spring,	2092
B.	Hominy cove at Salomon Davis's,	2542
B.	Little Pisgah west,	4724
B.	Great Pisgah,	5757

Big Pigeon Valley.

B.	Forks of Pigeon at Col. Cathey's,	2701
B.	East fork of Pigeon, at Cap. Th. Lenoir's,	2855
B.	Waynesville, courthouse,	2756
B.	Sulphur spring, Richland Valley, at James Love's, Esq.,	2716
B.	Mr. Hill's farm, on Crabtree creek,	2714
B.	Crab Tree creek, below Hill's farm,	2524
B.	Cold Mountain,	6063

Chain of the Richland Balsam, between Richland Creek and Big Pigeon River.

B.	Richland creek, at E. Medford's,	2038
B.	E. Medford's farm, foot of Lickstone Mt.,	3000
B.	Lickstone Mountain,	5707
B.	Deep Pigeon Gap,	4907
B.	Cold Spring Mountain,	5915
B.	Double Spring Mt.,	6380
B.	Richland Balsam, or Caney fork Balsam divide,	6425
B.	Chimney Peak,	6234
B.	Spruce Ridge Top,	6076
B.	Lone Balsam,	5898
B.	Old Bald, head of Richland Creek,	5786

Chain of Westener Bald.

B.	Westener Bald North Peak,	5414
B.	" " " Pinnacle,	5692

Great Middle Chain of Balsam Mountains between Scott's Creek and Soco Creek.

B.	Enos Plott's farm North foot of chain,	3002
B.	Old Field Mountain,	5100
B.	Huckelberry Knob,	5484
B.	Enos Plott's Balsam first Balsam North End,	6097
B.	Junaleska, or Jones' Balsam N. Point,	6233
B.	" " S. End,	6055
B.	Rockstand Knob,	6002
B.	Brother Plott,	6246
B.	Amos Plott's Balsam, or Great divide,	6278
B.	Rocky-face,	6081
B.	White-Rock Ridge,	5528
B.	Black-Rock,	5815
B.	Panther-Knob,	5359
B.	Perry Knob,	5026

Valley of Scott's Creek.

B.	Love's Sawmill, on Richland Creek,	2911
B.	Maclure's farm " "	3285
B.	Road Gap head of Scott's Creek,	3357
B.	John Brown's farm, Scott's Creek Valley,	3049
B.	Bryson's farm,	2173
B.	John Love's Esq., farm,	2296
B.	Webster Courthouse,	2203

Valley of Tuckasegee and tributaries.

B.	Tuckasegee River and mill below Webster, near road to Qualla,	2004
B.	Junction of Savannah creek,	2001
B.	" " Scott's creek,	1977
B.	Quallatown, main store,	1979
B.	Soco River, ford to Oconaluftee,	1990
B.	Soco Gap, road summit,	4341
B.	Amos Plott's farm, in Jonathan's Creek Valley,	3084

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		Height.
B.	Oconaluftee River, junction Bradley fork,	2203
B.	Robert Collins, Esq., highest house,	2500
B.	Junction of Ravens, and Straight forks,	2476
B.	Junction of Bunch's creek,	2379

CHAIN OF THE GREAT SMOKY MOUNTAINS.

North of Road Gap.

B.	Luftee Knob, head of straight fork of Oconaluftee River,	6283
B.	Thermometer Knob,	6157
B.	Ravens Knob,	6230
B.	Tricorner Knob,	6188
B.	Mt. Guyot, (so-named by Mr. Buckley), in Tennessee,	6636
B.	Mt. Henry,	6373
B.	Mt. Alexander,	6447
B.	Mt. Alexander, South peak,	6299
B.	The Three Brothers, highest or central peak.	5907
B.	The Thunderknob,	5682
B.	Laurel peak,	5923
B.	Reinhardt Gap,	5220
B.	Top of Richland Ridge,	5442
B.	Indian Gap,	5317
B.	Peck's peak,	6283
B.	Mt. Ocona,	6185
B.	Right hand, or new Gap,	5096
B.	Mt. Mingus,	5694

Group of Bullhead, Tennessee.

B.	Central peak or Mt. Leconte,	6612
B.	West peak, or Mt. Curtis,	6568
B.	North peak, or Mt. Safford,	6585
B.	Cross Knob,	5981
B.	Neighbor,	5771
B.	Master Knob,	6013
B.	Tomahawk Gap,	5450
B.	Alum Cave,	4971
B.	Alum Cave creek junction with little Pigeon River,	3848

Great Smoky Mountains, South of Road Gap.

B.	Road Gap,	5271
B.	Mt. Collins,	6188
B.	Collins Gap,	5720
B.	Mt. Love,	6443
B.	Clingmann's Dome,	6660
B.	Mt. Buckley,	6599
B.	Chimzy Knob,	5588
B.	Big Stone Mt. head of Forney Ridge,	5614
B.	Big Cherry Gap,	4838
B.	Corner Knob,	5246
B.	Forney Ridge peak,	5087
B.	Snaky Mountain,	5195
B.	Thunderhead Mountain,	5520
B.	Eagle Top,	5433
B.	Spence Cabin,	4910
B.	Turkey Knob,	4740
B.	Opossum Gap,	3840
B.	North Bald,	4711
B.	The Great Bald's Central Peak, near the Gap of Little Tennessee,	4923
B.	" " " South Peak,	4708
B.	Tennessee River, Hardin's,	899
B.	Chilhowee Mt. Summit road to Montvale Springs,	2452
B.	Montvale Springs Tennessee, Main Building,	1293

The numerous altitudes measured in the summer of 1860 during an exploration of two months not being ready for publication, will be given in another communication.

Princeton, New Jersey, January, 1861.

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Art. XIV.—*On the Formation of Picramic Acid;* by M. Carey Lea.

It is to Mr. Aimé Girard that we owe the first isolation of picramic acid, and correct determination of its constitution. His views however of the circumstances under which it is formed do not altogether agree with the results of my observations, and I advert to them now, because his second paper contains a criticism on the results obtained by another chemist, which criticism I think depends upon an inexact view of the reactions.

In a paper published by Dr. Evan Pugh in Liebig's Annalen, he endeavored to establish the identity of picramic acid with Wöhler's nitrohæmatic acid. Mr. Girard, while he agrees with Mr. Pugh in his conclusions, rejects his experiments and reasonings as insufficient.

"This chemist, in fact" he says "proceeded exactly as Mr. Wöhler had done before I demonstrated the formation of picramic acid by means of sulphydric acid. His process consists in mixing picric acid with protosulphate of iron, boiling with excess of baryta, precipitating the soluble baryta salt with ammoniacal acetate of lead and *finally in decomposing the lead salt by sulphydric acid.* Now it is evident that under these circumstances, even supposing that the protoxyd of iron had not converted the picric acid to picramic, the sulphydric acid alone would have produced this reduction." *

At first sight this conclusion seems perfectly legitimate, so much so, that it is probable that no test by experiment was thought necessary. Had such been made it would have been ascertained that sulphydric acid *is wholly without power to reduce* picric acid whether free or in combination with lead, to picramic acid.

The fact appears to have been overlooked that sulphydric acid is quite incapable of producing this reaction either upon picric acid, or as far as my experiments go, upon any picrate. It is the alkaline sulphids that possess this power, and not free sulphydric acid, a circumstance which has not been noticed, in consequence of chemists operating on solutions of picric acid in alcohol to which excess of ammonia had been added. When sulphydric acid is passed through such a solution, sulphydrate of ammonia is formed and acts on the picric acid.

Sulphydric acid may be passed through solutions of picric acid, picrate of potash or picrate of ammonia, either at ordinary temperatures, or at a boiling heat, for any length of time, without producing the slightest effect. On the addition of excess of alkali the reducing effect of the sulphid formed is immediate.

Philadelphia, Nov. 30, 1860.

* Comptes Rendus, xlii, 59.

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ART. XV.—*Remarks on a proposed Process for the Estimation of Nitrogen, and on an Acidimetric Process;* by M. CAREY LEA.

IN a late number of the London Chemical News* a modification of Will and Varrentrapp's process for the estimation of nitrogen is proposed by Mr. J. Walker. He decomposes the substance in a combustion tube in the ordinary way, but instead of conducting the products of the combustion into chlorhydric acid, conducts them into solution of chlorid of zinc, and in place of determining the ammonia in the usual manner, determines the amount of oxyd of zinc precipitated by it. "This process," the author observes, "has been practised by me for the last two years, and gives most accurate results, and I can with perfect confidence recommend it."

Few chemists would be apt to adopt a process so obviously worthless, but as its author recommends it especially for the analysis of manures, and as in that way it might be employed for technical purposes, it seems desirable that its gross inaccuracy should be pointed out. Oxyd of zinc is well known to be easily soluble in ammonia salts: if a drop of caustic ammonia is let to fall into a solution of pure neutral chlorid of zinc, it occasions a precipitate of oxyd, if now solution of sal-ammoniac be added, the precipitate redissolves. Obviously if more ammonia, instead of sal-ammoniac, is added, sal-ammoniac is formed by the decomposition of the zinc salt, and a portion of the precipitate is redissolved by it, or to speak more correctly, a portion of the oxyd of zinc which is liberated by the ammonia, is held in solution by the sal-ammoniac. The necessary result must be an under-estimation of the ammonia, leading to errors of such magnitude as would render the process wholly unfit even for the roughest technical process.

In consequence of overlooking the frequent solubility in alkaline solutions of certain metallic oxyds and basic salts insoluble in water, even chemists of experience have been led into singular errors. Dr. Friedrich Mohr in his interesting book on Volumetric Analysis, highly recommends a process proposed by Kieffer for acidimetric estimation, and which is briefly as follows. Sulphate of copper in solution is treated with liquid ammonia until the precipitate formed is nearly redissolved; it is then filtered, diluted to a certain strength and constitutes the test liquid. If this be dropped into an acid, or an acid solution, after the addition of a certain quantity a precipitate falls, the appearance of which Kieffer and Dr. Mohr consider to mark the moment

* Nov. 24, 1860, p. 280.

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of the exact saturation of the acid liquid by the joint action of the ammonia and copper. Dr. Mohr observes:*

"Donc le moindre excès de la liqueur de dosage formera un précipité bien net, tout à fait insoluble dans la dissolution des deux sels complétement neutres."†

Here is an important error, this precipitate is by no means insoluble in such solutions, it is soluble with considerable facility in solution of sulphate of ammonia (in the above passage Dr. Mohr refers more particularly to the dosing of sulphuric acid) and also, though to perhaps not to so great an extent, in solutions of sal-ammoniac and of nitrate of ammonia. Consequently when the precipitate appears, it is because the solution is saturated with it. If it were not that the effect of the cupro-ammoniacal solution is directed to be determined empirically and not by calculation, this solubility would have led to discrepancies no doubt sufficiently great to have awakened suspicion. But the error is just sufficiently great to make the process dangerous. More or less of the precipitate is held in solution according as the saline solution is more or less dilute. Consequently if the liquid to be analyzed contains no saline matter, the error may be but trifling, the error in the analysis correcting more or less accurately the original error in the determination of the "titre." This mode of estimation is particularly recommended for determining the quantity of free acid in acid saline solutions, but here is just where it would be most fallible, the nature and quantity of the saline substance in solution exerting a powerful influence on the solubility of the precipitate. It is evident that a solution containing 5 grammes of free sulphuric acid with 5 grammes of sulphate of ammonia, tested in this way, would give quite a different result from one in which 5 grammes of free acid was contained with 20 or 50 of sulphate of ammonia. Likewise its results when used in the "method of residues" must be false. Accordingly in an experimental trial by Dr. Mohr‡ for the determination of magnesia by supersaturation with a known quantity of sulphuric acid, and determination of the residue of uncombined acid, the result which he obtained is erroneous by 4 per cent. Four per cent too little of magnesia were obtained, because the free sulphuric acid was over-estimated, the ammonio-cupric solution having been added till a precipitate was obtained, which as we have just seen, does not fall till *after* the saturation point has been reached.

The precipitate which appears in all these cases is spoken of by Dr. Mohr as hydrated oxyd of copper. It appears to be basic (probably quadrobasic) sulphate.

* Not having a German copy at hand I quote from the French translation made by Forthomme under the superintendence of Dr. Mohr.

† Forthomme's translation, p. 409.

‡ Op. cit., p. 412.

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In making these observations on a single process of Dr. Mohr, I wish at the same time to bear testimony as to the candor with which he has given the results of his experimental trials. The proposal of a mode of analysis such as that of Mr. Walker is a new proof how much it is to be regretted that any chemist should offer a new mode of analysis, without having first controlled it by the analysis of one or more specimens of substance of a known composition. In this way MM. Glénard and Guillermond have recently proposed* a method of estimating the quinine in barks. It has been however shown† that not only the presence of cinchonine destroyed the accuracy of these results, but that owing to a mistake of the authors as to the reaction of the sulphates of quinine upon tincture of logwood, the process when performed with pure quinine gave only one-half the true result.

In connection with the foregoing observations on zinc I may remark that an error has crept into the description of zinc reactions in Gmelin's Handbook. It is there stated that zinc salts give preciptates with ferrocyanid and ferridcyanid of potassium, both of which are soluble in chlorhydric acid.‡ As respects the precipitate with ferrocyanid, this is certainly erroneous, the precipitate does not redissolve in that acid.

Philadelphia, Dec. 28, 1860.

Art. XVI.—*On the Dimorphism of Arsenic, Antimony and Zinc;* by Josiah P. Cooke, Jr.

The rhombohedral forms of arsenic, antimony and zinc are well known. Those of arsenic and antimony have been determined by several observers,§ and that of zinc first observed by Nöggerath,‖ on a furnace product from the smelting works of the Vieille Montaigne Zinc Co., near Aix la Chapelle, was subsequently redetermined on the same specimen by Gustav Rose.¶ It is the object of the present paper to show that these elements may also crystallize in regular octahedrons and therefore that they are dimorphous. Supposed monometric crystals both of arsenic and zinc have been previously described but since these observations have been discredited, the author has thought it best to publish his results.

Arsenic.—In the "Journal für praktische Chemie," vol. xxii, 344, 1841, Elsner describes, as crystals of arsenic, octahedrons,

* Rep. de Chimie Appliquée, 1859, p. 131. † Idem, 1860, p. 61.

‡ Handbook, vol. v, p. 12, Cavendish edition.

§ See description of a crystal of rhombohedral arsenic, in Proceedings of American Academy of Arts and Sciences, vol. iii, 86.

‖ Poggendorff Annalen, vol. xxxix, 323. ¶ Ibid., lxxxiii, 129.

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which he obtained by subliming a mixture of arsenious acid and charcoal powder. The author repeated the experiment of Elsner and obtained very distinct octahedral crystals, having a nearly black color and bright lustre, which were undoubtedly the same as those observed by Elsner. Similar crystals made by subliming the commercial arsenic, "cobalt," in a glass flask were at first sight mistaken by the author for crystals of arsenic. Their true nature however became evident on boiling the crystalline mass in water when it all dissolved with the exception of a small quantity of a black amorphous powder, the amount varying with different specimens. The substance dissolved was easily recognized as arsenious acid, and the black powder as finely subdivided metallic arsenic. The octahedrons were evidently merely crystals of arsenious acid containing as a mechanical mixture, particles of metallic arsenic like the sand in the crystals of Fontainbleau limestone. This result led the author to make a series of experiments with a view of testing the possibility of crystallizing pure metallic arsenic in forms of the monometric system. In one experiment rhombohedral crystals of arsenic, which had been prepared by sublimation in the usual way, afterwards kept under water, deprived of air by boiling, and just before using dried in a current of hydrogen, were introduced into a glass flask. Through this flask which was fitted with a cork and glass tubes for the purpose, a gentle current of hydrogen was maintained, the gas entering at the top and passing out near the bottom of the flask. As soon as the flask was known to be filled with hydrogen, the arsenic was sublimed in this atmosphere, when it condensed around the neck forming the well known metallic mirror. On subsequently breaking the flask and examining the mirror with a microscope (power of eighty diameters) it was found to be studded with distinct octahedral crystals having a greyish color and a bright metallic lustre. These octahedrons were recognized as belonging to the monometric system first by measuring the angles of the triangular faces and finding that they were equilateral triangles, second by the general "habitus" of the crystals especially in their distorted forms which could never be mistaken for truncated rhombohedrons, the only form with which they were liable to be confounded. The crystals were strictly microscopic and could not be distinguished with a pocket lens except as brilliant points. The precautions taken in the preparation seemed to exclude the possibility of any arsenious acid being present, but in order to establish this fact beyond a doubt, a portion of the metallic crust studded with the crystals was boiled in water for several minutes and afterwards treated with the strongest aqua ammoniæ for twenty-four hours, but the crystals were not dissolved by either reagent nor was their sharpness apparently impaired.

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In another experiment arseniuretted hydrogen gas was reduced in a bohemian glass combustion tube in the usual way, when testing for arsenic only on a larger scale and with special precaution in order to ensure the exclusion of air from the apparatus, and to regulate the quantity of arseniuretted hydrogen in the current of hydrogen gas. To one end of the combustion tube was connected by a cork a small exit tube whose open end dipped under mercury the other end was connected by means of a tube having two branches each provided with a stop-cock with a hydrogen generator on the one hand and on the other with a gas bottle generating arseniuretted hydrogen. The last was provided with a safety tube by which the excess of gas not needed in the experiment might escape. Before heating the combustion tube it was filled with hydrogen from the generator by which a uniform current of gas through the tube was maintained during the process. A portion of the tube two or three inches long was next heated to a red heat and then by opening the stop-cock a very small amount of arseniuretted hydrogen was allowed to mix with the hydrogen current and the experiment continued until a metallic mirror was formed on the glass beyond the heated portion of the tube. This mirror examined by the microscope, was found to be studded with minute octahedral crystals, which were submitted to the same test as before and with the same results.

Antimony.—No crystals of this metal except the well known rhombohedral forms ever appear to have been observed. Hauy formerly supposed that he had discovered in antimony the four cleavage planes of the regular octahedron and the six cleavage planes of the regular rhombic dodecahedron, but his observations were made on the ordinary regulus of antimony, which is now known to have rhombohedral cleavages. After crystallizing arsenic in octahedron by the process last described the author succeeded in obtaining octahedral crystals of antimony with the same apparatus, using antimonuretted hydrogen in place of arseniuretted hydrogen. The tube was heated with a Bunsen's gas burner to as high a temperature as it was capable of yielding and the process conducted as before. On breaking the tube and examining the metallic mirror with a microscope it was found studded with minute octahedral crystals. They were more readily obtained than the corresponding crystals of arsenic and presented the same characteristic forms. The solid angles of the octahedrons were very frequently observed modified by the faces of the cube and in one case at least the edges were truncated by the faces of the rhombic dodecahedron. These modifications are of importance as they remove all doubt in regard to the system of crystallization. The crystals being microscopic their interfacial angles could not of course be measured, but the

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existence of these modifications is even more satisfactory evidence on this point than an actual measurement.

It is well known that oxyd of antimony is capable of crystallizing in octahedrons belonging to the monometric system and although from the construction of the apparatus it was deemed impossible that any sensible amount of air could become mixed with the hydrogen in the tube, yet in order to remove all doubt on the subject, the crystals were exposed to the following reagents.

A portion of the glass tube covered with crystals was first boiled for a long time in water and subsequently treated with the strongest liquid hydrochloric acid; but although exposed to the action of the acid for several days in a warm room, the crystals were not dissolved. They also resisted for some time the action of boiling hydrochloric acid, but after prolonged boiling they disappeared. Exposed to the action of chlorine gas at a very gentle heat, the crystals were immediately consumed, leaving no residue and rendering the gas cloudy from the fumes of chlorid of antimony. Lastly, a portion of the tube (on which was deposited nothing but distinct octahedral crystals), was treated with a few drops of nitric acid, and a gentle heat applied. The crystals were at once attacked and the familiar white powder of antimonious acid was the result. This dissolved on adding a few drops of hydrochloric acid and the solution evaporated nearly to dryness, diluted with a solution of tartaric acid and subsequently treated with a solution of sulphid of hydrogen, gave the familiar red precipitate of sulphid of antimony.

In the metallic mirrors of arsenic and antimony obtained by Marsh's test, the metals seem to be always in the octahedral modification, and when deposited slowly are more or less crystalline. The author has obtained the best crystals by resubliming the metallic mirrors, after they were first formed, in a slow current of hydrogen, and it is in this way very easy to obtain the crystals entirely isolated on the surface of the glass tube, and in the case of antimony the author has traced with the microscope every gradation between the distinct crystals and the granular coating, which forms the mass of the mirror. The process of crystallization in the formation of the mirror is similar to that of sal-ammoniac on a glass plate and the lines of crystals shoot out in the same way parallel to the axis of the tube.

Zinc.—In the "Annales de Chimie et de Physique," vol. xxii, 37, 1848, Nicklès has described some crystals of pure zinc prepared by M. Favre with the process of M. Jacquelain as pentagonal dodecadrons but unfortunately he has given no measurement of angles to confirm his opinion. This observation has been questioned by Gustav Rose* on the grounds first that the

* Poggendorff, Annalen, vol. lxxxv, 293.

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mamillary concretions of zinc, which are frequently deposited on the cooler portion of the retort during the process of distillation might readily be mistaken for pentagonal dodecahedrons without any exact measurement of angles, and secondly that this form which is characterized by a peculiar law of symmetry, has never been observed unless this case is an exception, on any metallic crystals. The question might readily be settled by a reëxamination of the original specimen and it is to be hoped that, if they still exist, such an examination will be made.

In "Poggendorff's Annalen," vol. cvii, 441, 1859, Gustav Rose has described two specimens of crystallized brass formerly belonging to the mineral collection of Klaproth, which show in the cavities of the mass distinct crystals. Rose infers that these crystals belong to the monometric system rather from their grouping as indicated by the striation than from the external forms of the individual crystals which was too indistinct to admit of exact determination. This subject has been much more fully studied by Mr. F. H. Storer in the laboratory of Harvard College. Storer obtained octahedral crystals composed of zinc and copper in the varying proportions of the constituents from pure copper to 70 per cent of zinc.* The crystals were made by fusing the metals in a crucible and pouring out the still liquid alloy after a crust had formed on the surface as in crystallizing bismuth or sulphur. They were all too ill-defined to admit of direct determination and although they exhibited similar striations to those described by Rose, the striæ did not seem to the author to fix the system of crystallization with such clearness as to exclude all doubt. There were however other circumstances which were thought to point out the system of the crystals; first, the crystals resembled precisely the artificial crystals of magnetic oxyd of iron which are frequently obtained as a furnace product, and which are known to belong to the monometric system. The author had recently the opportunity of comparing with the brass crystals a very finely characterized specimen of this magnetic oxyd in the mineral collection of Dr. Krantz at Bonn. Second, the whole series of crystals including those of pure copper had the same characters and if the crystals of copper were monometric, as no one will question, the rest are also. But assuming that the octahedrons in question are monometric, this fact has no bearing upon the crystallizing form of zinc unless it can be also shown that there is no definite chemical combination between the zinc and the copper, or in other words, that the alloys of those metals are nearly isomorphous mixtures. Storer has proved this point as the author thinks, conclusively, by analyzing the series of crystals as well as the alloys in which they were formed. The full details of his results will be found in his

* See an abstract of Storer's paper at the close of this Number.

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memoirs in vol. vi, of the Memoirs of the American Academy of Arts and Sciences. It is sufficient for the present purpose to state that the composition of the crystals was in every case sensibly the same as that of the alloy.

This investigation seems to prove that zinc is capable of assuming a monometric condition and thus of crystallizing in connection with copper in the same way that sulphate of copper may be made to crystallize in connection with sulphate of iron, taking the form of green vitriol although it generally assumes the form of another system. But although his results are conclusive as far as they go, Storer could not obtain crystals containing more than 70 per cent of zinc. The alloys of zinc and copper containing more than this per cent of zinc become granular on cooling, and do not yield distinct crystals. The following observations of the author may therefore be of value in extending the history of the subject.

During the course of some experiments on the compounds of zinc and arsenic a furnace product was accidentally obtained composed of these two elements imperfectly fused together and mixed with cinders. The cavities of this mass were lined with very brilliant octahedral crystals having a bright metallic lustre. The crystals although small could be easily measured with a reflective goniometer and gave the exact angle of the monometric octahedron. A sufficient number of the crystals for analysis was separated with some difficulty from the gangue. They were dissolved in dilute hydrochloric acid and the zinc precipitated with carbonate soda was determined in the usual way. The result gave

Zinc,	81·18
Arsenic,	18·82
	100·00

The quantity of arsenic in these crystals is so much smaller than the amount required to form any probable definite compound that there can be but little doubt that it is present as impurity and that the octahedrons are an isomorphous mixture of the two elements. The presence of a certain amount of impurity seems to favor metallic crystallization and it is possible that it may be the disposing cause in this case, inducing as it were a monometric condition in the zinc. The beautiful lead crystals containing a small quantity of antimony which are obtained at the smelting works near Clausthal in the Harz, are familiar to mineralogists, and the author has found that a small quantity of lead on the other hand greatly facilitates the crystallization of antimony. Similar facts have been noticed in the case of bismuth so that distinct crystallization instead of being the test of purity in the case of a metal is quite the reverse. To what extent the presence of these impurities may effect the crystalline form of the metal

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has not yet been determined but it is certain that this influence is important and that it depends as well on the amount as on the nature of the impurity. Laurent and Holms (Ann. de Chimie et Phys., [2], vol. lx, 333), state that zinc containing a few per cent. of iron crystallizes in rhombic prisms, and Warren de la Rue also (Philosophical Magazine, vol. xxvii, 370) has analyzed and measured rhombic prisms of zinc having the composition, zinc 90·00, iron 2·56, lead 6·00, copper 1·44. Acicular crystals having a similar composition have also been described by Erdmann, (Berzelius, Traité, ii, 620). Moreover the author observed in a furnace product similar to the one above described some flexible acicular crystals which he analyzed and found to consist of zinc 91·3, arsenic 8·7. These crystals could not be crystallographically determined but they were undoubtedly similar in form to those before described and entirely different from the octahedral crystals noticed above. Is it not possible that all the prismatic crystals of zinc, which have been described, including those of Nöggerath and Rose, may belong to the same crystalline system? If so the apparent anomaly presented by the above facts would disappear, and as the observers themselves do not claim that the crystalline system has in either case been determined beyond a doubt, this is not an improbable supposition; moreover the authority for the rhombohedral system rests on a single specimen, which, as Rose admits, is not capable of exact determination crystallographically and has never been analyzed. However these facts may be regarded, the octahedral crystals above described appear to the author to confirm the view that zinc is capable of crystallizing in the monometric system, but he does not attach to the observation any weight except as confirming previous results, and as furnishing additional data for the solution of the problem.

Cambridge, Nov. 14, 1860.

ART. XVII.—*General Account of the Results of Part* II. *of the discussion of the Declinometer Observations made at the Girard College, Philadelphia, between* 1840 *and* 1845, *with special reference to the Solar Diurnal Variation and its Annual Inequality;* by A. D. BACHE, Superintendent U. S. Coast Survey.

(Read before the Amer. Assoc. for the Adv. of Science, at Newport.)

THE discussion presented last year to the Association embraced the amplitude of the solar diurnal magnetic variation, as well as that of the number and magnitude of the disturbances of declination, in reference to the eleven years' period, heretofore pointed out by General Sabine and others. The discussion now presented, is of the annual solar diurnal variation and its annual

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inequality. The complete results of the computations, as in the other case, will be given in the Smithsonian Contributions to Knowledge, and the present paper will contain merely a general account of the results.

The normals, or means, freed from the disturbances, are used in the discussion, avoiding thus the necessity for rejecting the observations of months in which disturbances are frequent. The same course is followed by the Rev. Professor H. Lloyd in his discussion of the Dublin observations and also by General Sabine in the third volume of the discussion of the Toronto observations. I therefore return to the hourly normals given in part (I.)* of the discussion, and arrange them according to months of the year, correcting those of 1845 for index error, as already explained. The tables given in the complete memoir, show at one view the mean hourly readings for each month unaffected by large disturbances, and the mean hourly position of the magnet in reference to its general mean position. The solar diurnal variation for each month is readily traced in the table, but the annual inequality in the diurnal variation being affected by the secular changes is less distinctly traceable. To give this result distinctness, each hourly normal is compared with the corresponding monthly mean value, as set down in the last vertical column of the table, and the results are recorded in a new table. The sign + in this latter table indicates a westerly, and the sign − an easterly deflection of the north end of the magnet from its mean position, the scale divisions having been converted into minutes of arc.

The distinctive features of this second table are brought out both analytically and graphically. The inequality in the diurnal variation is most readily seen by comparing the horizontal lines of the table from August and February and the annual variation appears most plainly by carrying the eye down the vertical columns for the hours of 6 and 7 A. M.

The annual variation depends upon the earth's position in its orbit, the diurnal variation being subject to an inequality depending upon the sun's declination. The range is greater during the summer, when the declination is north, and less during the winter when the declination is south, and passes from one to the other about the time of the equinoxes. The summer and winter means are therefore tabulated for comparison with the general mean. Diagram A shows the type curve for the summer and winter periods and the general mean of the year. The summer months, April to September inclusive, give a diurnal range of nearly $10\frac{1}{2}$ minutes and the winter months one of $5\frac{1}{2}$ minutes. Diagram B shows the same results in a different form, the mean yearly curve of the first diagram (A) being straightened out to form the axis of the second (B). The curves represent the win-

* This Jour., [2], vol. xxix, p. 36.

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ter and summer variations, the ordinates being the difference between those of the yearly curve, and of the winter and summer curves respectively. This diagram shows very perspicuously the progress of the annual variation at different hours of the day. It shows that at 6 or 7 A. M. the annual variation is a maximum, disappearing at a quarter before 10 A. M. That it reaches a second, (secondary,) maximum at 1 P. M. nearly disappearing shortly after 5 P. M. A still smaller maximum is reached after 9 P. M. and half an hour before midnight the annual variation again disappears. At, and before, and after the principal maximum between 6 and 7 A. M. the annual variation causes the north end of the magnet to be deflected to the eastward in the summer and to the westward in the winter. At 1 P. M. the deflections are to the west in summer and to the east in winter; the range of diurnal motion being thus increased in the former season and diminished in the latter. The needle is thus deflected in summer, more to the east in the morning hours and more to the west in the afternoon hours, or has greater elongation than it would have if the sun moved in the equator. In winter the reverse is the case. The range of annual variation from summer to winter at Philadelphia is about 3′, and its daily range about 2′·6.

In diagram C similar curves are given for Philadelphia, St. Helena, Toronto and Hobarton, of the winter and summer progress of the annual variation. The comparison indicates that Toronto and Hobarton are not normal types of the half yearly deflections and the near coincidence of the forms at Philadelphia and St. Helena, seems to show that the type for different places is one and the same in general character, affected by incidental irregularities.

In reference to the annual variation, Gen. Sabine, in the rectifications and additions to the last volume of Humboldt's Cosmos, expresses himself as follows:

"Thus in each hemisphere the semi-annual deflections concur with those of the mean annual variation for half the year and consequently augment them, and oppose and diminish them in the other half. At the magnetic equator, there is no mean diurnal variation, but in each half year the alternate phases of the sun's annual inequality constitutes a diurnal variation of which the range in each day is about 3′ or 4′, taking place every day in the year, except about the equinoxes, the march of the diurnal variation being from east in the forenoon to west in the afternoon when the sun has north declination and the reverse when south declination." According to the same authority the *annual* variation is the same in both hemispheres, the north end of the magnet being deflected to the east in the forenoon, the sun having north declination, whereas in the *diurnal* variation the north

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end of the magnet at that time of the day, is deflected to the east in the northern hemisphere and to the west in the southern; In other words, in regard to direction, the law of the annual variation is the same as that of the diurnal variation, but opposite in passing from the northern to the southern magnetic hemisphere.

Some interesting conclusions as to the law of change of the annual variation, will flow from a closer discussion of the observations at the two hours of maximum, namely 6 to 7 A. M. and 1 to 2 P. M. The general table, by subtracting the annual mean from each monthly value, at the respective hours, gives the following values for the annual variations at or near the hours of principal and secondary maxima of range, the signs + and − indicating as usual westerly, or easterly deflection from the annual mean position.

	6 to 7 A. M.	1 to 2 P. M.		6 to 7 A. M.	1 to 2 P. M.
	′	′		′	′
January,	+2·01	−0·98	July,	−1·94	+1·25
February,	+1·31	−1·12	August,	−2·66	+1·31
March,	+0·47	−0·47	September,	−1·24	+0·82
April,	+0·15	+1·06	October,	+1·41	−1·14
May,	−1·38	+0·93	November,	+1·47	−1·35
June,	−1·90	+0·89	December,	+2·30	−1·20

The greatest range at 6 to 7 A. M. is 5′·0 the easterly deflection being greater than the westerly by 0′·4. That from 1 to 2 P. M. is 2′·7, the eastern and western deflections being equal. A general inspection of the columns shows that the solstices are approximately the turning epochs of this annual variation, and that the signs change at the time of the equinoxes. To determine these points with the more precision the numbers of the table were expressed by an analytic formula. According to this, January 1st and July 1st (ten days after the solstices) are the dates of the greatest values, and the transition from positive to negative values, and the reverse will occur on the first of April and first of October (ten days after the equinoxes).

A table is given in the memoir showing the satisfactory coincidence of the observed and computed values. This result agrees with that deduced by a different method by General Sabine.

To give a definite determination of the law of the phenomenon, so as to embrace the whole progress shown by the series, the regular solar diurnal variation has been expressed as a function of the time, by four terms of Bessel's formula, the equation being found for each month, and also for each half year from April to September and from October to March and also for the whole year. Allowance was made in determining the coefficients for the different weight of the readings at the even and at the odd hours.

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The equation for the whole year is compared with that given by Prof. Lloyd for Dublin. Reference is made to the monthly equations deduced by Mr. Karl Kreil from a consecutive series of observations made at Prague from 1840 to 1849, and selected from a longer series of thirteen years.

The following table exhibits the close correspondence of the computed and observed mean annual value of the regular solar diurnal variation.

Philadelphia mean time.	Diurnal variation. Compared.	Diurnal variation. Observed.	Difference.	Philadelphia mean time.	Diurnal variation. Compared.	Diurnal variation. Observed.	Difference.
h m				h m			
0 19½	−0·49	−0·47	−0·02	12 19½	+3·69	+3·65	−0·04
1 "	−0·48	−0·51	+0·03	13 "	+4·28	+4·32	+0·04
2 "	−0·51	−0·44	−0·07	14 "	+3·81	+3·77	−0·04
3 "	−0·67	−0·71	+0·04	15 "	+2·77	+2·76	−0·01
4 "	−1·09	−1·19	+0·10	16 "	+1·71	+1·80	+0·09
5 "	−1·82	−1·64	−0·18	17 "	+0·88	+0·78	−0·10
6 "	−2·77	−2·72	−0·05	18 "	+0·33	+0·25	−0·08
7 "	−3·49	−3·47	−0·02	19 "	−0·07	−0·07	−0·00
8 "	−3·44	−3·50	+0·06	20 "	−0·38	−0·33	−0·05
9 "	−2·29	−2·43	+0·14	21 "	−0·57	−0·60	+0·03
10 "	−0·24	−0·19	−0·05	22 "	−0·62	−0·64	+0·02
11 "	+2·03	+2·17	+0·14	23 "	−0·57	−0·71	+0·14

The greatest difference at any one hour is less than 11″ and the probable error of any single computed value is ±0″·19.

Diagrams D and E give the resulting curves for the computed hourly values of the diurnal variation for each month of the year. Diagram D contains the curves for the six months of the summer half year and E, for six months of the winter half year. Positive ordinates correspond as before to a westerly motion of the north end of the needle, and negative ordinates to an easterly motion. Diagram F contains the type curves for the summer, winter and the whole year.

From the computed values as given in the the table assisted by the diagrams, the general features of the diurnal variation and of its annual inequality are readily deduced.

The general character of the diurnal motion is nearly the same for the summer half year, for the winter half and therefore for the whole year. The greatest eastern deflection is, at a mean, reached a quarter before eight A. M. being a quarter of an hour earlier in summer, and half an hour later in winter. Near this hour the declination is a minimum. The greatest western deflection is reached, at a mean, at a quarter after one o'clock P. M., a few minutes earlier in both the summer and winter. At this hour the declination is a maximum. The diurnal curve presents but a single wave, slightly interrupted by a deviation occurring during the hours near midnight, or from 10 P. M. to 1 A. M. when the magnet has a direct or westerly motion. Shortly after 1 A. M. the north end of the magnet moves easterly, completing the

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cycle, and arriving at its eastern elongation shortly before 8 A. M. This nocturnal deviation is well marked in winter, vanishes in summer and is but slightly perceptible in the annual curve. According to the investigations of General Sabine, it is probable that if the effect of disturbances was completely obliterated in the results, this small oscillation would disappear. In summer when it is not noticed the needle remains nearly stationary from 8 P. M. to 3 A. M. The type curves for the year, show a similar result. The diurnal curves for the months when the sun's declination is north, and those when it is south, resemble each other closely, as is shown by diagrams D and E.

For greater precision in regard to the epoch and amount of the diurnal variation we must recur to the analytical expressions representing the numbers of the table.

The following table contains the results for each month and for the summer and winter seasons and the whole year, also the critical interval between the two adjacent hours of the mean positions.

Month.	Eastern elong. A. M.	Western elong. P. M.	Critical interval from min. to max.	Epoch of mean declination.		Critical interval.
				A. M.	P. M.	
	h m	h m	h m	h m	h m	h m
January,	8 58	1 27	4 29	10 52	7 08	8 16
February,	8 34	1 32	4 58	10 52	7 26	8 34
March,	8 07	1 34	5 27	10 46	7 32	8 46
April,	8 12	1 27	5 15	10 34	7 40	8 56
May,	7 29	1 21	5 52	10 19	6 57	8 38
June,	7 33	1 20	5 47	10 25	8 26	10 01
July,	7 36	1 28	5 52	10 30	9 32	11 02
August,	7 18	1 05	5 47	10 10	8 40	10 30
September,	7 30	0 45	5 15	9 58	6 45	8 47
October,	8 00	1 17	5 17	10 30	5 23	6 53
November,	7 54	1 08	5 14	10 16	6 08	7 52
December,	8 54	1 40	4 46	10 50	6 17	7 27
Summer,	7 33	1 08	5 35	10 17	7 43	9 26
Winter,	8 24	1 25	5 01	10 40	6 49	8 09
Year,	7 48	1 16	5 28	10 26	7 08	8 42

The formulæ also give for the time of the seondary minimum of eastern declination in winter $9^h\ 42^m$ P. M. and for its amount $-0'{\cdot}97$.

For the time of the secondary maximum of western declination in winter, $1^h\ 15^m$ A. M., and for its amount $-0'{\cdot}26$; differences $3^h\ 33^m$ and $0'{\cdot}71$.

For the secondary minimum of eastern deflection for the year, $10^h\ 11^m$ P. M. and its amount, $-0'{\cdot}62$.

For the secondary maximum of western deflection for the year, $1^h\ 13^m$, and its amount $-0{\cdot}47$; differences $3^h\ 02^m$ and $0'{\cdot}15$.

The effect of the season on the critical hours is well marked in the foregoing table, the eastern elongation occurring earliest between the summer solstices and the autumnal equinox, and latest about the winter solstice.

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The eastern elongation occurs earliest about the winter solstice and the same holds good for the morning epoch of the mean declination. The afternoon epoch, however, occurs earliest shortly after the autumnal equinox, and latest shortly after the summer solstice. The critical hours which are most constant during the year, are those of the western elongation and of the morning mean declination. The greatest difference between any month and the mean of all the months, is 31 minutes in the former and 28 in the latter.

To exhibit the features of the diurnal variation and its annual inequality, a graphical representation is given in diagram G. The magnetic surface is formed by contour lines 0′·5 apart. The curves in dots (....) are lines of mean position. Those in dashes (- - - -) are eastern deflections from the normal position and the full lines are western deflections. This Diagram and the table from which it is deduced are immediately applicable to the practical problem of furnishing the correction to be applied to a single observation, made at any hour of the day and month, to reduce it to its mean value. It also renders unnecessary the development of the annual variability of the coefficients in the analytical expression. The diagram distinctly exhibits the diurnal minima and maxima, the former represented by a valley, the latter by a ridge, on the magnetic surface.

Next, the magnitude of the diurnal range is studied. The following table exhibits the amount of the deflection at the eastern and western elongation and the diurnal amplitude of the declination for each month in the year derived from the equations.

	Deflection at E. Elong.	Deflection at W. Elong.	Diurnal range.		Deflection at E. Elong.	Deflection at W. Elong.	Diurnal range.
Jany.	−2′·46	+3′·52	5′·98	July.	−5′·58	+5′·46	11′·04
Feby.	−2 ·64	+3 ·11	5 ·75	Aug.	−5 ·79	+6 ·36	12 ·15
March.	−3 ·73	+4 ·03	7 ·76	Sept.	−4 ·71	+5 ·60	10 ·31
April.	−4 ·02	+5 ·28	9 ·30	Oct.	−2 ·18	+3 ·23	5 ·41
May.	−4 ·89	+5 ·16	10 ·05	Nov.	−1 ·92	+2 ·85	4 ·77
June.	−5 ·26	+5 ·06	10 ·32	Dec.	−1 ·65	+3 ·14	4 ·79

The diurnal range for the summer months is 10′·45, for winter months 5′·56, and for the whole year 7′·89, all corresponding to an epoch about a year and a half removed from the epoch of a minimum of the solar period.

The numbers denoting the diurnal range, exhibit three remarkable features, namely, the maximum value in August, the sudden falling off in September and October, (Diagram H,) and the minimum value in November and December. In other respects, the progression is regular. The curve is single crested, which holds in the eastern, as well as the western deflections when viewed separately. This is of special importance, as it is probable that the interference of these separate curves at other

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stations chiefly determine the double crested character of the curves of diurnal range. The curves for Milan, Munich, Göttingen, Brussels, Greenwich, Dublin, etc., for instance, exhibit two maxima, one after the vernal equinox and a second, generally the smaller, about the summer solstice. The system to which Philadelphia belongs, is exemplified by the annual progress of the diurnal range at Prague and certain Russian stations, as at Nertschinsk, but more closely by Toronto as seen in Diagram H. Neither station appears to have a tendency to a secondary maximum about the month of April, so that the maximum about a month and a half after the summer solstice, is a well marked feature of the North American stations.

In connection with the preceding discussion the inequality in the magnetic declination from year to year next claims attention.

This subject presents greater inherent difficulties than the diurnal inequality, on account of the difficulty of keeping the instrument in precisely the same condition of adjustment throughout the year. In the first part of the discussion, I had occasion to refer to this circumstance while investigating the annual effect of the secular change, and it was then shown that the Philadelphia observations share in this respect a similar difficulty with other stations in consequence of which the results must be received with caution.*

In the mean monthly values of the declinometer readings and in their differences, when compared month for month, are combined the joint effect of the secular change, and of the annual inequality. To eliminate the effect of the secular change, conditional equations were formed, which give a value deduced by the application of the method of least squares, of 1·227 divisions, as the monthly effect of the secular change.† The effect of the secular change was deduced from the mean monthly values, and these values themselves being subjected to certain corrections, which the numbers show to be necessary, the following result for the annual inequality was obtained.

* Dr. Lloyd's instructive note on this subject in his discussion of the Dublin observations is as follows: "The determination of the annual variation is much more difficult than that of the diurnal, both on account of the much smaller frequency of the period and the difficulty of preserving the instrument in the same unchanged condition during the much longer time, or of determining and allowing for its changes when they do occur; accordingly, although the annual period may be traced in the observations of Gilpin and is decidedly displayed in those of Bowditch, it has evaded the researches of recent observers. There is but a faint indication of its existence in the Göttingen observations, which were made at the hours of 8 A. M. and 1 P. M., and Prof. Gauss and Dr. Goldsmith, find in the analysis of these observations no important fluctuations dependent upon season. A similar negative result is deduced by Dr. Lamont from the Munich observations which were made twelve times a day.

† This value 6′·7 of annual change, though not preferable to the value (4′·5) deduced by a different method in part I of this discussion, must necessarily be employed in the present investigation. The most reliable value 5′·0 was deduced from independent observations, as already announced.

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	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean declinom. readings,	56·°	563·1	563·5	562·6	561·1	562·2	562·1	561·2	558·4	558·1	564·6	564·4
Corr. for secular change,	−4·4	−3·6	−2·8	−2·0	−1·2	−0·4	+0·4	+1·2	+2·0	+2·8	+3·6	+4·4
Annual variation in arc,	+0·5	+0·4	−0·1	−0·1	+0·2	−0·6	−1·0	−0·9	0·0	−0·2	+0·9	+0·7

This result has been adopted as representing the annual variation. From June to October the north end of the magnet is accordingly to the eastward of the mean annual position, (after the elimination of the secular change,) and in the remaining months of the year, it is to the westward of this position. From the vernal equinox until after the summer solstice, the motion is to the eastward, or retrograde in regard to the advance of the secular change, (to the westward). This is in conformity with the law given by Dr. Lloyd in the Dublin discussions, the motion of the magnet there being to the westward at that period of the year, or the reverse of the Philadelphia deflection. The secular change is also reversed. The west declination diminishing at Dublin between 1840 and 1843. The results for annual inequality from seven years of observation at Toronto, are also brought out and compared with the Philadelphia results. The secular change at Toronto was 2′0, whilst at Philadelphia (1843) it was 4′4. In regard to the amount of the inequality, the two stations agree remarkably well, the range remaining slightly below 2′ of arc. It is supposed that this range at the same station is increasing, or diminishing, as the secular change increases or diminishes.

ART. XVIII.—*The Upper Silurian Beds of Western Tennessee; and Dr. F. Roemer's Monograph;* by Prof. J. M. SAFFORD, Lebanon, Tenn.

To no part of Tennessee has the attention of American palæontologists been more frequently directed than to the region of "the glades," in the western part of the State. Recently attention has again been called to this region by the publication of Dr. Roemer's valuable and elegant monograph.* For this work, which we welcome with great pleasure, we are much indebted to Dr. Roemer. It presents a unique local fauna of great interest. Setting aside a few forms, the species he enumerates and describes belong to a bed of calcareous shales and limestones equivalent to the Niagara group of New York. This bed I have denominated for some time past, in my unpublished notes, the 'sponge-bed,' or the sponge-bearing bed, the appropriateness of which name is at once seen by referring to Dr. Roemer's monograph.

* Die Silurische Fauna Des Westlichen Tennessee; Eine Palæontologische Monographie von Dr. Ferdinand Roemer; Breslau, 1860. See this Journal, xxxi, 127.

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The object of this article is to point out the fact that the fauna illustrated in the above work is not the only one occurring upon the glades. Heretofore not a little confusion has existed with reference to the different beds of this region. To this day, so far as the writer knows, no complete sections have been published. To present the number and order of the beds, and to prepare the way for a clear understanding of the formations and their condition, the following section, selected from the materials gathered for my Report upon the Geology of Tennessee, is given. It was made in the northern part of Wayne county. The successive beds crop out along a line, which commencing at the level of the Tennessee river (low water) at Clifton, and running back nearly four miles, terminates at the top, and on the end of one of the spurs, or fingers, that jut out from the high flat lands further east. The beds are arranged in descending order. The term Niagara is made to include both the Clinton and Niagara groups of New York.

Carboniferous.		9. Top of ridge overlooking the valley of Eagle Creek. Strata concealed; loose cherty masses scattered over the surface containing occasional fossils, 53 feet.
Devonian, *Hamilton group?*		8. Strata (when weathered) *bluish or greenish siliceous shale.* Eight feet at the base interstratified with thin, smooth, fine-grained sandstones which are charged with individuals of a small *Lingula*, 42 feet.
		7. *Fine-grained sandstone* highly charged with the same *Lingula* as above, 8 feet.
Upper Silurian.	*Lower Helderberg?*	6. *Grey crinoidal Limestone*—Fossils obscure at this point,—the horizon, however, of well marked Lower Helderberg rocks at other points in Wayne county, 25 feet.
	Niagara, the Sponge-Bearing Bed.	5. *Glade-forming Limestones and Calcareous Shales.*—The limestone grey often coarse crinoidal—sometimes argillaceous—All very fossiliferous—occasionally containing layers of chert, 90 feet.
	Niagara, the Variegated Bed.	4. *Variegated Limestone;* brownish-red and grey layers interstratified—many layers argillaceous—*orthocerata* abundant in lower part, 96 feet.
Lower Silurian. *Hudson River.*		3. *Greenish calcareous Shale*, containing *Leptæna sericea*, and *Strophomena alternata*, 15 feet.
		2. *Blue Limestone* in rough thick-bedded layers containing *Strophomena alternata, S. tenuistriata, Rhynconella increbescens, R. dentata,* Cyclonema bilix, Columnaria stellata, &c., 21 feet.
		1. *Blue fine-grained Limestone*—in thin smooth layers separated by shaly leaves—has been used as "Hydraulic Limestone"—contains *Orthis testudinaria, Rhynconella modesta, Lingulæ, Trilobites,* &c., 70 feet.

The beds numbered 4, 5, and 6, represent all the glade-forming limestones and shales, and it is to these that attention is especially invited. In this part of Wayne county, their entire thickness is seen to be 211 feet.

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No. 4. *Variegated Limestone.*—This bed, the first I notice, rests directly upon the Hudson river rocks. The junction is well seen at Clifton and below that place, for several miles, along the eastern bank of the Tennessee river. This bed is seen in the glade region occupying generally a low position. Outside of Wayne and Hardin counties its base is rarely seen. The vicinity of Clifton is the most favorable place for studying the entire bed, that has come under my observation.

It is easily recognized by interstratified brownish-red layers, some of which, when crinoidal, furnish a pretty good marble. It is, however, often argillaceous and crumbling.

Its red color, due to sesquioxyd of iron, may indicate its Clinton affinities.

This bed is, in general, comparatively barren in fossils. Occasionally its layers are crinoidal. *Atrypa reticularis*, and several species of *orthocerata* are met with. At Clifton, the base of the bed, the entire mass, is exceedingly rich in individuals of several species of *orthoceras* and in large crinoidal stems and roots. The sponges especially are abundant.

No. 5. *Gray Limestones and Shales*, or the *Sponge-bearing Bed.*—This is the division to which Dr. Roemer's fauna belongs. It is a series of gray crinoidal limestones and calcareous shales, the latter often predominating. On the sloping marly glades the layers of limestone frequently crop out in two or three successive ledges separated by masses of shale. Thin layers of chert often occur interstratified with the limestone. Fossils abound, among them *Astraeospongia meniscus* is very characteristic, in fact the mass might well be called the *Meniscus bed.*

The general thickness of the bed is from 80 to 100 feet. In this respect, however, it is quite variable; at a few points the thickness is reduced to 30 and even to 20 feet. In the section above it is given at 90 feet; it is quite possible, however, that a portion of the overlying bed (as in it, at this point, no characteristic fossils were observed) ought to be included, thus making the thickness to a small extent greater.

The *Sponge-bearing Bed* is the prevalent rock of the glades in Hardin, Wayne, Decatur and Perry counties. It also occurs, to some extent, in Humphreys, Benton and Henry.

Nearly all of the species given by Dr. Roemer in his monograph are found in this bed. There are a few, however, which, so far as my observations extend, are confined to the bed next above, having been seen, *in place*, only in these rocks; the most important, perhaps, is *Pentamerus galeatus*. *Spirifer macropleura*, (*S. Niagarensis*, var. *oligoptycha* of the monograph) although in New York a Lower Helderberg form, is properly included in this fauna as it occurs in this as well as in the overlying bed. *Calceola Tennesseensis*, Roemer, is the same as *C. Americana*,

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Safford, described in a previous number of this Journal, (vol. xxix, p. 248). The latter name must give place to the former. On a future occasion I shall have remarks to make upon other species given in Dr. Roemer's monograph.

No. 6. *Lower Helderberg.*—We come now to a bed of strata presenting a fauna quite different from that illustrated by Dr. Roemer. It occurs well marked at numerous points within the glade region and in the counties mentioned. The place of this bed is immediately below the Devonian shales and sandstones cropping out, when present, from beneath those on the hill-sides. At many points it is the surface rock. Many of the glades, with naked summits, present only Niagara rocks. Some, however, are capped by this formation. This division, as a bed, and looking over the whole region, is to a considerable extent cut up and fragmentary.

In thickness it varies much; at some points it is entirely absent, No. 7 or 8 resting immediately upon the Sponge-bearing bed; then again it swells out to 60 or 70 feet, and perhaps to as much as 100 feet although I have not any where, as yet, measured so great a thickness.

So far as it regards the particular section presented, it is not certain that No. 6 is wholly, or even in part, Lower Helderberg, no characteristic fossils having been seen. It marks, however, the horizon of these rocks. Within a few miles of this point, the bed holding this position is well characterized in good sections.*

To my mind it is evident, that this bed was subjected to very considerable denudation before the deposition of the Devonian shales and sandstone; hence its variable thickness, or its absence when, in complete sections, the latter rocks are present. Going further back, I have reason to think that the floor of Niagara rocks, upon which this bed rests, was also previously subjected, (but not in so great a degree,) to denudation, and hence the varying thickness of the Niagara bed. This, too, will explain what appears to be the fact, that where the Niagara bed is thin the other becomes thicker, the two in this respect being, to a certain extent, complementary to one another. The Helderberg sediments filled up the hollows and basins of the partially denuded Niagara floor.

Lithologically the bed under consideration cannot easily be distinguished from the one below it. But its fossils, as a whole,

* I take this opportunity of expressing my thanks to my friend and former pupil, A. B. Gant, Jr., of Cravens Mills, Wayne county, for valuable assistance rendered me in my investigations on Indian and Eagle creeks. Mr. Gant has discovered several most interesting localities of fossils in both Wayne and Hardin counties. His ability and zeal promise much more with reference to the interesting geological features of this region.

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are quite different. Here the characteristic sponges of the Niagara bed disappear; and so do the crinoidal forms so well illustrated by Dr. Roemer.

In their places we have other species, mostly brachiopods, the larger portion of which are known to occur in the Lower Helderberg rocks of New York. Below is a list of some of the described species. These have all been collected by the writer from the bed in question. Most of them may be found in all, or nearly all the counties bordering the Tennessee river. With the exception of the last, they have all been compared directly with New York specimens.

Eatonia (Atrypa) singularis.
Merista (") laevis.
" (") bella, Hall.
Rhynchospira formosa, Hall.
" globosa, Hall.
Nucleospira ventricosa, Hall.
" concentrica, Hall.
Pentamerus Verneuili, Hall.
" galeatus, Hall.
Rhynchonella mutabilis, Hall.
Orthis subcarinata, Hall.
" oblata, Hall.
" varica, Hall.
Spirifer perlamellosa, Hall.
Strophomena punctulifera, Conrad.
Phacops Hudsonicus, Hall.
Anisophyllum Agassizi, Edwards and Haime.

Dr. Roemer's beautiful species, *Rhynchonella Tennesseensis*, as well as *Athyris tumida*, as he has it, ought perhaps to be included in the Lower Helderberg fauna; I have seen many perfect individuals of the first in these rocks, and but a few uncertain fragments in the debris of the Niagara, or Sponge-bed; of the second species, but few individuals have come under my observation and I am more in doubt as to its true position.

The following among the brachiopods given in the monograph are common to the two beds; Atrypa reticularis, Rhynconella Wilsoni, Orthis elegantula, Spirifer ("Niagarensis") macropleura and Strophomena depressa.

Within a few months I hope to be able to present a more detailed and systematic account of these rocks, together with complete lists of the fossils they contain.

Lebanon, Tenn., January, 1861.

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ART. XIX.—*Correspondence of* JOACHIM BARRANDE, SIR WILLIAM LOGAN *and* JAMES HALL, *on the Taconic System and the age of the Fossils found in the Rock of Northern New England, and the Quebec Group of Rocks.*

I. INTRODUCTORY REMARKS.

As some of our foreign readers may not be acquainted with the question to which the following important correspondence relates, we think it advisable to make a few explanatory observations by way of introduction. A complete history of the whole subject would require a greater amount of space than can be afforded and we shall therefore touch only upon a few of the more salient points.

The rocks under discussion occupy a belt of country east and west from twenty to sixty miles wide, stretching from the vicinity of the city of New York in a northerly direction to Lake Champlain and thence through Vermont and Lower Canada to Cape Gaspé at the mouth of the St. Lawrence. The strata consisting of slates, limestones, sandstones and conglomerates are greatly disturbed, plicated and dislocated, and are often, especially along the eastern side of the belt, in a highly metamorphic condition. On this side they are overlaid unconformably by upper Silurian and Devonian rocks, but on the western and northern margin they are in contact with and in general seem to be a continuation of the Lower Silurian. Some of the slates of the formation closely resemble in lithological characters those of the Hudson River group and thus along the western side of the region, where the junction of the two formations occurs, it is often almost impossible to draw the line between them. The dip and strike of both are in the same direction and throughout extensive areas the newer rocks appear to plunge beneath the older. The whole district affords an excellent example of those cases, so well known to field geologists, where the true relations of the different masses cannot be clearly worked out without the aid of fossils and where the best of observers may arrive at diametrically opposite opinions.

Dr. Emmons, one of the geologists of the New York Survey, early convinced himself by a careful examination of these rocks, that they constituted a distinct physical group more ancient than the Potsdam sandstone, the latter being regarded by him as the base of the Lower Silurian System in North America. His views were given in detail in 1842 in his final report on that part of the State confided to his charge, and in a more special manner in another work entitled "THE TACONIC SYSTEM," published in 1844. In this latter work he figured several species of fossils which had been collected in different parts of the formation. Two of these were trilobites and were described under

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the names of *Atops trilineatus* and *Elliptocephala asaphoides*. The others were graptolites, fucoides and apparently trails of annelides; he considered all the species to be distinct from any that had been found in American rocks of undoubted Silurian age. The pre-silurian age of the formation has also been maintained by him in several more recent publications such as his "American Geology"—the several reports on the geological survey of North Carolina and in his "Manual of Geology."

On the other hand, Professor Hall placed the whole region in the Hudson River group. In the first volume of the Palæontology of New York he identifies *Atops trilineatus* with *Triarthrus Beckii* the characteristic trilobite of the Utica slate;—*Elliptocephala asaphoides* he refers to the genus *Olenus* and describes as congeneric therewith another trilobite (*O. undulostriatus*) said to be from the true Hudson River shales. It is scarcely necessary to state that these identifications have always afforded an extremely powerful objection against the correctness of the position assumed by Emmons, because no species of trilobite is known to range from the Primordial Zone up to the top of the Lower Silurian. Hall's first volume was published in 1847 and as it is unquestionably the most important work on the Lower Silurian Fossils of North America it has been very generally accepted by our physical geologists as a guide. It is not surprising therefore that, in all the discussions that have taken place during the last fourteen years upon the age of these rocks, the majority of those who did not profess to be naturalists should have arranged themselves on the side of the leading Palæontologist of the country.

The formation was traced from New York through Vermont and there identified, by Prof. Adams the State Geologist, with the Hudson River group. The Canadian Surveyors continued it with great labor through a mountainous and partially uninhabited country for nearly five hundred miles further, from the northern extremity of Vermont to the neighborhood of Quebec and thence along the south side of the St. Lawrence to the mouth of that river at Cape Gaspé. In Canada the nomenclature of the New York Survey was adopted for all the formations and it appears from his several reports that Sir W. E. Logan could find nothing in the physical structure of the country to authorize him to make an exception in favor of this particular series of rocks. It has therefore always been called the Hudson River group in the publications of the Canadian Survey.

It will be seen by the following correspondence that the new light thrown upon the question of the age of these rocks by the fortunate discovery of a large number of fossils near Quebec, now leads him to place them at the base of the Lower Silurian, and as he states that the shales in Vermont in which the trilobites no-

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ticed in Mr. Barrande's letter to Prof. Bronn have been found may be subordinate to the Potsdam it seems probable that the sequence contended for by Emmons will turn out to be at least for the greater part the true one.

II.

ON THE PRIMORDIAL FAUNA AND THE TACONIC SYSTEM OF EMMONS, IN A LETTER TO PROF. BRONN OF HEIDELBERG.*

"Paris, July 16, 1860.

"..... I have recently received, thanks to the kindness of Mr. E. Billings, the learned palæontologist of the Geological Survey of Canada, a very interesting pamphlet entitled 'Twelfth Annual Report of the Regents of the University of the State of New York, 1859.' If you possess this publication, you will find there, at page 59, a memoir of Prof. J. Hall, entitled 'Trilobites of the Shales of the Hudson River Group.' This savant there describes three species under the names *Olenus Thompsoni*, *Olenus Vermontana*, and *Peltura* (*Olenus*) *holopyga*. The well-defined characters of these trilobites are described with the clearness and precision to be expected from so skillful and experienced a palæontologist as James Hall.

"Although the specimens are incomplete, their primordial nature cannot admit of the least doubt, when the descriptions are read, accompanied with wood engravings which the large dimensions of these three species render sufficiently exact. The first is 105 millim. long by 80 broad, the other two are somewhat smaller.

"The heads of the two *Oleni* being deteriorated, the furrows of the glabella cannot be recognized. The thorax has a common and remarkable character, which consists in the greater development of the third segment, the point of which is stronger and longer than in all the other pleura. This is a striking resemblance to the *Paradoxides*, the second segment of which has the same peculiarity. Besides, there is an intimate relation between these two primordial types, and we should not be surprised if America furnished us with forms uniting most of their characteristics. The pygidium of *O. Thompsoni*, the only one that is known, shows no segmentation, and attests by its exiguity its relation to a primordial trilobite. *P. holopyga*, by its whole appearance, resembles the species of Sweden so well known by the name of *P. Scarabæoides*.

"Thus all the characters of these three trilobites, as they are recognized and described by J. Hall, are those of the trilobites of the primordial fauna of Europe. This is so true, that I think I may say without fear, if M. Angelin, or any other palæontologist practised in distinguishing the trilobites of Scandinavia, had met with these three American forms in Sweden or Norway, he would not have hesitated to class them among the species of the Primordial fauna, and to place the schists enclosing them in one of the formations containing this fauna. Such is my profound conviction, and I think any one who has made a serious study of the trilobitic forms and of their vertical distribution in the oldest formations will be of the same opinion.

* Proceed. Boston S. N. Hist., vol. vii. Dec., 1860, p. 371.

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"Besides, all who have seriously studied palæontology know well that each geological epoch, or each fauna, has its proper and characteristic forms, which once extinct reappear no more. This is one of the great and beautiful results of your immense researches, which have generalized this law, recognized by each one of us within the limits of the strata he describes.

"The great American palæontologist arrived long since at the same conclusion, for in 1847 he wrote the following passage in the *Introduction* to the first volume of the Monumental Work consecrated to the Palæontology of New York.

"'Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms. We are more and more able, as we advance, to observe that the Author of nature, though always working upon the same plan and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence have performed their parts in the economy of creation, have lived their period and perished. This we find to be as true among the simple and less conspicuous forms of the palæozoic series, as in the more remarkable fauna of later periods.'—*J. Hall*, '*Pal. of New York*,' i, p. xxiii."

"When an eminent man expresses such ideas so eloquently, it is because they rise from his deepest convictions. It must then be conceived that J. Hall, restrained by the artificial combinations of stratigraphy previously adopted by him, has done violence to his palæontological doctrines, when, seeing before him the most characteristic forms of the *Primordial fauna*, and giving them names the most significant of this first creation, he thinks it his duty to teach us that these three trilobites belong to a horizon *superior* to that on which the second fauna is extinguished.

"In effect, according to the text of J. Hall, the three trilobites in question were found near the town of Georgia, Vermont, in schists which are superior to the *true Hudson River group*. In his works J. Hall does not go beyond indicating the horizon of certain fossils, and no one would think of asking a guaranty for such indications. But on this occasion the great American palæontologist thinks it necessary to support his stratigraphical determination by another authority, chosen from the most respectable names in geology. The following is the note which terminates his Memoir.

"'Note.—In addition to the evidence heretofore possessed regarding the position of the shales containing the Trilobites, I have the testimony of Sir W. E. Logan, that the shales of this locality are in the upper part of the Hudson River group, or forming a part of a series of strata which he is inclined to rank as a distinct group, above the Hudson River proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent.'

"Now, when a savant like J. Hall thinks himself obliged to invoke testimony to guarantee the exactness of the position of a few fossils, it is clear that the determination of this position is difficult.

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"In order to understand these difficulties I have consulted the maps and documents relating to the State of Vermont and the country in which the town of Georgia is situated, and, although the library of our Geological Society does not contain all that one could wish on this subject, I recognized easily that Georgia is placed in the region where the order of succession of the deposits is the most obscured by foldings and dislocations; so that the position of the schists in question could not have been determined by the incontestable evidence of direct superposition. Besides, the physical appearance of these schists is not that of the rocks constituting the typical group of Hudson River. This is verified by the Note of J. Hall, for it tells us that Sir W. E. Logan is inclined to make a distinct group of these schists *superior* to that of the Hudson, and which consequently *would crown the whole Lower Silurian division* of the continent.

"For the above reasons, the geological horizon on which the three *Oleni* of Georgia were found appears to me, at first view, to have been but doubtfully determined, and in complete opposition to palæontological documents.

"I do not think, then, that I weaken in the least degree the respect and confidence justly inspired by the labors of the American savants whose names have just been mentioned, when I ask them in the name of science to make new researches and new studies, that may lead to a final and certain solution of this important question.

"Doubtless, thanks to the progress of our knowledge, we are now no longer bound by the ancient conception of the simultaneous extinction and the total renovation of the faunæ. As for myself, in particular, it would not be possible to accuse me of similar views at the moment when I am publishing the explanation of my doctrine of colonies. But you will perceive that the facts which I invoke in support of this doctrine are far from sustaining the reappearance of a fauna after the extinction of the following fauna, which the three trilobites of Georgia would do, if they had really lived after the deposit of the Hudson River group.

"This reappearance would be still more astonishing, as among the three great Silurian faunæ the second fauna occupies the greatest vertical space and is probably the one which enjoyed the longest existence. Thus, to verify such a reappearance, the most incontestable proofs are required, for such a decision would compel the entire re-formation of one of our most important scientific creeds. "Yours very truly,

J. BARRANDE."

In another letter, dated Paris, 14th August, 1860, Mr. Barrande says:—

"You will easily perceive the interest and importance of the question, even if it were only raised on account of the three *Oleni* of Georgia; but it takes in now a much wider field, owing to a letter I have just received from Mr. Billings, official Palæontologist of the Geological Survey of Canada, who informs me that he has found lately, in the schists and limestones near Quebec, considered as being the prolongation of those in question in Vermont, nearly one hundred species, almost all new. Twenty-six of these come from a white limestone, and seem to him to be the true representatives of the Primordial fauna, and he cites among them *Conocephalites*,

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Arionellus, *Dikellocephalus*, etc., that is, very characteristic forms of this fauna.

"In another limestone, which is gray, he finds thirty-nine species, all different from the first, and representing, on the contrary, the most distinct types of the second fauna. Finally, the black schists furnish him with *Graptolites*, *Lingulæ*, etc., etc., fossils which at first sight cannot determine a horizon, because they are found upon several Silurian horizons.

"While waiting for these very obscure stratigraphical relations to be disentangled, and without committing in any manner Mr. Billings, who should preserve the independence of his opinion, I may yet express to you my view wholly personal, and of which at this moment I take the entire responsibility. I think, then, that this region of schists and limestones of Vermont, in other words the *Taconic system*, will reproduce in America what took place in England as to the Malvern Hills, and in Spain for the Cantabrian chain,—that is to say, the Primordial fauna, after having been disregarded, will regain its rights and its place, usurped for a time by the second fauna.

"You see it is a great and noble question, whose final solution will complete the imposing harmonies existing already between the series of palæozoic faunæ of America and that of the contemporaneous faunæ of Europe, leaving to each the imprint peculiar to its continent.

"I can well imagine, from the position previously taken by our learned American brethren on the subject of the Taconic system, that the final solution of which I speak will not be obtained without debate, and perhaps some wounding of self-love, for some opinions that appear to be dominant must be abandoned.

"But experience has taught me that in such cases the most elevated minds turn always first to the light, and put themselves at the head of the movement of reform. Thus, when in 1850 I recognized the Primordial fauna in the Malvern Hills, where the second fauna only had been found, Sir Henry de la Beche and Sir Roderick Murchison were the first to adopt my views, to which little by little the other official geologists agreed; Edward Forbes ranged himself publicly on my side in 1853 in 'The Geological Survey,' while others still hesitated, until now there is no longer any opponent.

"I think there will be the same experience in America, and that in a few years from this time the opinions of your savans will have undergone a great change as regards this question.

"It is a fine opportunity for Dr. Emmons to reproduce his former observations and ideas with more success than in 1844.

"Yours very truly,

J. BARRANDE."

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III.

REMARKS ON THE FAUNA OF THE QUEBEC GROUP OF ROCKS AND THE PRIMORDIAL ZONE OF CANADA.* (IN A LETTER ADDRESSED TO MR. JOACHIM BARRANDE OF PARIS, BY SIR WILLIAM E. LOGAN, DIRECTOR OF THE GEOL. SURVEY OF CANADA.)

Montreal, 31st Dec., 1861.

My Dear Mr. BARRANDE:

I am much indebted to you for your letter of the 6th of August, which was accompanied by a copy of your communication to Professor Bronn of Heidelberg, dated 16th July. Agreeably to your request, I took an early opportunity of letting Mr. Hall have a copy of your communication to Prof. Bronn, and he received it on the 11th or 12th September, 1860.

I am of course aware, from the correspondence you have had with my friend Mr. Billings and myself, how far you are acquainted with our discoveries at Quebec. On two occasions, just previous to the receipt of your last letter to Mr. Billings (received the 8th November), I devoted the short time I could spare from other engagements connected with the Geological Survey, to farther researches at Point Levi. I have satisfied myself, notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata. Without entering at present on minute details of structure, I may say that the chief part of the specimens, found up to this time, are from two parallel out-crops, which might be taken as representing two distinct layers. If they are such, they are comprehended in a thickness of about 150 feet; but the circumstances of the case, connected with the physical structure, make it probable that the one band is a repetition of the other through the influence of an anticlinal fold or a dislocation. Both out-crops dip to the southeastward.

From the more northern out-crop (which we shall call A^2) we have obtained *Orthis* 1, *Leptæna* 1, *Camerella* 1, *Lingula* 2, *Discina* 1, *Agnostus* 3, *Conocephalites* 1, *Arionellus* 4, *Dikellocephalus* 6, *Bathyurus* 4. From the more southern out-crop (which we shall call A^3) we have *Dictyonema* 1, *Orthis* 2, *Leptæna* 1, *Strophomena* 1, *Camerella* 1, *Cyrtodonta* (?) 1, *Murchisonia* 3, *Pleurotomaria* 7, *Helicotoma* 2, *Straparollus* 2, *Capulus* 2, *Agnostus* 1, *Bathyurus* 4, *Cheirurus* 2, *Amphion* 2. From a third out-crop, which is still farther southward, and supposed to be another repetition of the same band (which we shall call A^4), we have *Orthis* 1, *Camerella* 1, *Asaphus* (*A Illænoides*) 1, *Bathyurus* 1. Tracing A^2 or A^3 round the extremity of a synclinal, and finding occasional indications of the fossils of A^2 and A^3, we arrive at a position on the south side of the synclinal. We shall call the position P. Here the band A^2 or A^3 ends, but a bed of

* Communicated to this Journal by Sir William Logan.

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sandstone a little above it is traceable over an anticlinal to a junction with a conglomerate band lower than A^2 or A^3, showing that A^2 or A^3 must merge into it. Call this A^1. In this we have *Asaphus* (*A. Illœnoides*) 1, *Menocephalus* (*M. globosus*) 1. These two species occur in the same fragment of rock. Of all these fossils, 1 *Orthis* is common to A^2, A^3 and A^4; 1 *Leptæna*, 1 *Camerella*, 1 *Lingula*, 1 *Agnostus*, and 1 *Bathyurus*, are common to A^2 and A^3; 1 *Asaphus* is common to A^3 and A^1.

The dip at P is to the southeastward, and therefore an inverted dip. Northwest of this, and therefore above it, at such a distance as would give a thickness of between 200 or 300 feet, we have a band of shale with nodules of limestone, the nodules made up of other rounded masses in a matrix holding fossils, many of them silicified. From a few of these compound nodules we have obtained *Orthis* 11, *Leptæna* 1; this band we shall call B^1. A band like this occurs about half a mile or more to the southwestward. It may be a higher band, or it may be the same band, but we shall call it B^2. From this we obtain *Crinoidæa* (columns) 3, *Orthis* 1, *Camerella* 1, *Nautilus* 1, *Orthoceras* 1, *Leperditia* 1, *Trilobites* (2 genera undetermined) 2. In another position to the southeast, on the southeast of the same anticlinal previously mentioned, we meet with a conglomerate band supposed to be the same as B^2; but, in case it should be different, we shall call it B^3. Here we have *Orthis* 3, *Pleurotomaria* 2, *Murchisonia* 1, *Ophileta* 1, *Helicotoma* 1, *Nautilus* 1, *Maclurea* 1, *Orthoceras* 3 or 4, *Cyrtoceras* 1, *Bathyurus* 1, *Illœnus* 2, *Asaphus* 1. Of all these fossils, 1 *Orthis* and 1 *Camerella* are common to B^1 and B^2; the same *Orthis* and *Camerella* with 1 *Leptæna* are common to B^1, A^4, A^3 and A^2.

To the north of all these exposures, and on the northwest side of a synclinal running parallel with the synclinal already mentioned, fossils have been obtained in a cliff of about 100 feet, composed of limestone conglomerate, thin bedded limestones and shales. Their equivalence is not yet quite certain, but the strata are supposed to be not far removed from A^1 and A^2. We shall call this cliff A. The fossils from it are *Tetradium* 1, *Orthis* 1, *Lingula* 2, *Trilobites* (genus undescribed) 1, with a great collection of compound *Graptolidæ*, described and being described by Mr. Hall under the genera *Graptolithus* 25, *Retiolites* 1, *Retiograptus* 2, *Phyllograptus* 5, *Dendrograptus* 3, *Thamnograptus* 3, *Dictyonema* 3.

I have given you these details of localities, because as the subject requires further investigation we do not yet wish to commit ourselves entirely as to the equivalency of separate exposures. But there is no doubt that the whole is one group of strata deposited under one set of alternating circumstances. The whole fauna, as known up to the present time, is composed of—

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Articulata,	36	species.
Mollusca,	55	"
Graptolidæ,	42	"
Radiata,	4	"
	137	

Of this fauna not one species is found in the Anticosti group, where we have a gradual passage from the fauna of the Hudson River formation to that of the Clinton, and not one of any formation higher than the Chazy. Mr. Billings recognizes one species, *Maclurea Atlantica* (Billings) as belonging to the Chazy, and six species as belonging to the Calciferous. They are *Lingula Mantelli* (Billings), *Camerella* undescribed, *Ecculiomphalus* undescribed, *Helicotoma uniangulata* (Hall), *H. perstriata* (Billings), and one remarkable species of an undetermined genus, like a very convex *Cyrtodonta*, which occurs both at Mingan and point Levi. All of the forms, particularly the trilobites, remind the observer of those figured by Dr. D. Dale Owen from the oldest fossiliferous rocks of the Mississippi valley, while independent of the six species identical with Chazy and Calciferous forms, there are many others closely allied to those found in the latter formation in Canada.

From the physical structure alone no person would suspect the break that must exist in the neighborhood of Quebec, and without the evidence of the fossils, every one would be authorized to deny it. If there had been only one or two species of an ancient type, your own doctrine of colonies might have explained the matter, but this I presume would scarcely be applicable to so many identities in a fauna of such an aspect. Since there must be a break, it will not be very difficult to point out its course and its character. The whole Quebec group, from the base of the magnesian conglomerates and their accompanying magnesian shales to the summit of the Sillery sandstones, must have a thickness of perhaps some 5000 or 7000 feet. It appears to be a great development of strata about the horizon of the Chazy and Calciferous, and it is brought to the surface by an overturn anticlinal fold with a crack and a great dislocation running along the summit, by which the Quebec group is bronght to overlap the Hudson River formation. Sometimes it may overlie the overturned Utica formation, and in Vermont points of the overturned Trenton appear occasionally to emerge from beneath the overlap.

A series of such dislocations traverses eastern North America from Alabama to Canada. They have been described by Messrs. Rogers, and by Mr. Safford. The one in question comes upon the boundary of the Province not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress; thence it

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coasts the north side of the Island of Orleans, leaving a narrow margin on the island for the Hudson River or Utica formation. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here again it leaves a strip of the Hudson River or Utica formation on the coast.

To the southeast of this line the Quebec group is arranged in long narrow parallel synclinal forms with many overturn dips. These synclinal forms are separated from one another on the main anticlinals by dark grey and even black shales and limestones. These have heretofore been taken by me for shales and limestones of the Hudson River formation, which they strongly resemble, but as they separate the synclinals of the Quebec group must now be considered older. I am not prepared to say that the Potsdam deposit in its typical form of a sandstone is anywhere largely developed above these shales, where the shales are in greatest force. Neither am I prepared to assert its absence, as there are in some places masses of granular quartzite, not far removed from the magnesian rocks of the Quebec group, which require farther investigation; but, from finding wind-mark and ripple-mark on closely succeeding layers of the Potsdam sandstone where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was even exposed at the ebb of tide. Out in deep water the deposit may have been a black partially calcareous mud, such as would give the shales and limestones which come from beneath the Quebec group.

In Canada no fossils have yet been found in these shales, but the shales resemble those in which *Oleni* have been found in Georgia (Vermont). These shales appear to be interposed between eastward dipping rocks equivalent to the magnesian strata of the Quebec group, and they may be brought up by an overlapping anticlinal or dislocation. We are thus led to believe that these shales and limestones, which may be subordinate to the Potsdam formation, will represent the true primordial zone in Canada.

Mr. Murray has this season ascertained that the lowest rock that is well characterized by its fossils in the neighborhood of Sault Ste. Marie, near Lake Superior, really belongs to the Birdseye and Black River group, and that it rests on the sandstones of Ste. Marie and Lacloche, the fossiliferous beds at the latter place being tinged with the red color of the sandstone immediately below them. These underlying Lake Superior rocks may thus be Chazy, Calciferous, and Potsdam, and may be equivalent to the Quebec group and the black colored shales beneath. The Lake Superior group is the upper copper-bearing

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series of that region, and rests unconformably upon the lower copper-bearing series, which is the Huronian system. The upper copper-bearing series holds nearly all the metals, including gold, and so does the Quebec group, each making an important metalliferous region. Each when unmetamorphosed holds a vast collection of red colored strata. The want of fossils in the Lake Superior group makes it difficult to draw lines of division, but if any part represents the primordial zone, I should hazard the conjecture that it is the dark colored slates of Kamanistiquia, which underlie all the red rocks.

Professor Emmons has long maintained, on evidence that has been much disputed, that rocks in Vermont, which in June, 1859 I for the first time saw and recognized as equivalent to the magnesian part of the Quebec group, are older than the Birdseye formation; the fossils which have this year been obtained at Quebec pretty clearly demonstrate that in this he is right. It is at the same time satisfactory to find that the view which Mr. Billings expressed to you in his letter of the 12th July, to the effect that the Quebec trilobites appeared to him to be about the base of the second fauna, should so well accord with your opinions; and that what we were last spring disposed to regard at Georgia as a colony in the second fauna, should so soon be proved, by the discoveries at Quebec, to be a constituent part of the primordial zone. I am, my dear Mr. Barrande,

Very truly yours,

W. E. LOGAN.

Mr. Joachim Barrande, Rue Mezière No. 6, Paris.

IV.

LETTER FROM JAMES HALL, PALÆONTOLOGIST OF NEW YORK, TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

Gentlemen,—In the Twelfth Annual Report of the Regents of the University* upon the State Cabinet of Natural History, I published descriptions of three species of Trilobites from the shales of the town of Georgia in Vermont, referring them to the age of the Hudson River group. These trilobites had been in my possession for some two years or more; and knowing the great interest that would attach to them, whenever published, I had waited, hoping that some new facts might be brought out touching the stratigraphical relations of these rocks in the town of Georgia.

After the descriptions had been printed and a few copies distributed, I learned that Sir William Logan was at that time

* The same to which Mr. Barrande refers in his text to Prof. Bronn, p. 312. The preceding communications sufficiently explain the subject under discussion.

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actually investigating the rocks of that part of Vermont. Desiring to know the results of his latest researches in regard to the stratigraphical relations of these rocks, I withheld the final publication till the Meeting of the American Association for the Advancement of Science, in Springfield, and there showed to Sir William my descriptions as they now stand in the Report, and I then received his authority for the addition of the note which was appended.

This in a few words is a simple history of the matter relating to the publication of these species. I made no remarks or comparisons with the primordial fauna of Barrande in Bohemia, knowing that these features would be at once recognized by every palæontologist; while their reference to the genus Olenus showed my appreciation of the nature of the fossils.

I received a copy of the communication of Mr. Barrande, from Sir William Logan in September, a few days before setting out for my field duties in Wisconsin. Since my return to Albany, constant and pressing occupation has left me no time to consider a reply to a question of so much importance.

Later discoveries in the limestones associated with the shales at Quebec leave no longer a doubt, if any could have been entertained before, that the shales of Georgia, Vermont, are in the same relative position; and we must regard these three trilobites as belonging to the same fauna with the species enumerated by Sir William Logan as occurring in the Quebec group. Left to palæontological evidence alone, there could never have been a question of the relations of these trilobites, which would at once have been referred to the primordial types of Barrande.

Sir William Logan yields to the palæontological evidence, and says, "*there must be a break.*" He gives up the evidence of structural sequence which he had before investigated and considered conclusive; and having heretofore relied upon the opinion of the distinguished Geologist of Canada in regard to a region of country to which my own examinations had not extended, I have nothing left me but to go back to the position sustained by palæontological evidence. Let us for a moment examine this palæontological evidence.

The identifications of the fossils of the Quebec group, certainly show a remarkable agreement between the trilobites of this group and those of the Potsdam sandstone, in the occurrence of *six species* of *Dikellocephalus* and one of *Menocephalus;* while the occurrence of many others is in agreement or not incompatible with the fauna of the Potsdam and Calciferous sandstones. The comparative values of the Trilobitic faunæ of this group and of the primordial zone of Europe, as established by Barrande, is better shown in a tabular form which I here append.

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The Crustacean fauna of the primordial zone of Europe.

Paradoxides, Olenus, Peltura, Conocephalus, Ellipsocephalus,* Hydrocephalus, Sao, Arionellus,	These genera are all limited to the *fauna primordiale*, and none of the other European genera of trilobites are known in this fauna.
Agnostus,	Of the first and second fauna.
Amphion,	Placed with doubt in the first fauna, and is well developed in the second fauna.

The Crustacean fauna of the Quebec Group.

Conocephalus, Arionellus,	Genera of the *primordial zone.*
Agnostus,	A genus passing from the first to the second fauna.
Dikellocephalus, Menocephalus,	Genera of the Potsdam period.
Bathyurus,	Quebec group.
Asaphus,	Of the second fauna.
Illænus,	Of the second and third fauna.
Amphion,	Of the second fauna; and doubtfully of the first fauna in Sweden.
Ceraurus = Chierurus,	Of the second and third Silurian faunæ, and of the Devonian fauna.

We have therefore in the Quebec Group, two established genera of the primordial zone; one, Agnostus, which passes from the primordial to the second fauna; one, Amphion, cited as doubtful in the first fauna in Sweden, and known to be in the second; and three,—Asaphus, Illænus and Chierurus, which begin their existence in the second fauna. Of these, Asaphus begins and ends in the second; Illænus begins with the second and continues to the third; while Ceraurus = Chierurus begins in the second, extends through the third Silurian, and appears in the Devonian fauna.

Bathyurus is a new genus, and as yet has no stratigraphical value in comparisons. Those which I described as Olenus have proved to be not true Oleni; and though much resembling that genus, are nevertheless distinct; and I have proposed the names *Barrandia* and *Bathynotus* for the two forms.† These have yet no stratigraphical value, except so far as their relations to established genera may aid in that direction.

The genera *Dikellocephalus* and *Menocephalus* are of the Potsdam group; and so far the Quebec group is in parallelism with the Potsdam and Calciferous strata.

Of the other genera, we know Asaphus, Illænus and Ceraurus (= Chierurus) in the Trenton limestone and Hudson River groups; Illænus and Ceraurus in the Upper Silurian strata of Niagara age, or the third fauna of Barrande; while Ceraurus

* Not Elliptocephalus of Emmons.

† Thirteenth Annual Report of the Regents of the University of N. Y., on the State Cabinet of Natural History, Albany, December, 1860.

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occurs also in the Devonian of Europe. Amphion is known in the second fauna in Europe, and, doubtfully in the first.

Ceraurus does not occur in this country, so far as I know, above the Niagara group; though known in the Devonian rocks of Europe.

The following tabular arrangement of the genera found in the Quebec group will serve to express more distinctly the relations of the Crustacean fauna of these rocks.

The letters at the head of the columns have the same references as those used in the communication of Sir William Logan.

	A	A^1	A^2	A^3	A^4	B^1	B^2	B^3
Arionellus,		—	4					
Conocephalus,		—	1					
Agnostus,		—	3	1				
Dikellocephalus,		—	6					
Menocephalus,	—	1	—	—	—			
Bathyurus,		—	4	4	1			1
Barrandia, } *Shales of*								
Bathynotus, } *Georgia, Vt.*								
Amphion,				2				
Asaphus,		1			1			1
Illænus,								2
Chierurus (Ceraurus),				2				
Leperditia,							1	
Lingula,	2	—	2					
Discina,		—	1					
Orthis,	1	—	1	2	1	11	1	3
Leptæna,		—	1	1		1		
Strophodonta,		—		1				
Camarella,			1	1	1		1	
Cyrtodonta?				1				
Maclurea,								1
Murchisonia,				3				1
Pleurotomaria,				7				2
Helicotoma,				2				1
Straporollus,				2				
Capulus,				2				
Ophileta,								1
Nautilus,							1	1
Orthoceras,							1	3 or 4
Cyrtoceras,								1
Crinoidal columns,							3	
Tetradium,	1							
Dictyonema,	3			1				
Graptolithus,	25							
Retiolites,	1							
Reteograptus,	2							
Phyllograptus,	5							
Dendrograptus,	3							
Thamnograptus,	3 [?]							

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In this table we find, of previously recognized trilobites of the primordial fauna, two genera and five species; of previously known genera of the second and third faunæ, *four genera* and eight species; *two genera* before known in the Potsdam sandstone and seven species; and of Agnostus, which is of the first and second faunæ, two species; and one new genus with nine species.

These are certainly very curious results; and a modification of our views is still required to allow four genera and eight species, (or leaving out Amphion) three genera and six species of the Trilobites of the second fauna to be associated with two genera and five species of Trilobites of the primordial fauna, and yet regard the rocks as of primordial origin.

The Brachiopodous genera, Lingula, Discina, Orthis, Leptæna and Strophomena, have a great vertical range, and are known in the Lower and Upper Silurian, and most of them in the Devonian; while Camerella so far as known is a Lower Silurian form of the second fauna (perhaps also in a lower position).

Of the Gasteropoda, Maclurea and Ophileta are restricted to Lower Silurian rocks, but occur mainly in the second fauna. The other genera occur likewise in the second fauna and in the Upper Silurian rocks as well as some of them in Devonian. The same is true of the Cephalopoda enumerated.

Tetradium is known in the second fauna of the Lower Silurian rocks, and in the upper part of the Hudson River group at the west. Dictyonema is a genus known from Lower Silurian to Devonian strata.

Graptolithus proper extends to the Clinton group of New York; and the same is true of Reteograptus. Thamnograptus occurs in the rocks of the Hudson River group near Albany, and in the Quebec rocks. Phyllograptus and Retiolites are known in the Quebec rocks only; while the typical form of Dendrograptus occurs in the Potsdam sandstone, and, likewise, in three other species, in the Quebec rocks.

We find, therefore, in the other genera except trilobites, very little satisfactory evidence, on which to rely in the present state of our knowledge, for determining the position of these strata.

In the present discussion, it appears to me necessary to go further, and to inquire in what manner we have obtained our present ideas of a primordial, or of any successive faunæ. I hold that in the study of the fossils themselves there were no means of such determination prior to the knowledge of the stratigraphical relations of the rocks in which the remains are inclosed. There can be no scientific or systematic palæontology without a stratigraphical basis. Wisely then, and independently of theories, or of observations and conclusions elsewhere, geologists in this country had gone on with their investigations of structural geology. The grand system of the Professors W. B. and H. D. Rogers had been wrought out not only for Pennsylvania and

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Virginia but for the whole Appalachian chain; and the results were shown in numerous carefully worked sections. In 1843, '44 and '45 I had myself several times crossed from the Hudson River to the Green Mountains, and found little of importance to conflict with the views expressed by the professors Rogers in regard to the chain farther south, except in reference to the sandstone of Burlington, and one or two other points, which I then regarded as of minor importance.

Sir William Logan had been working in the investigations of the geology of Canada; and better work in physical geology has never been done in any country.

This then was the condition of American geology, and investigators concurred, with little exception, in the sequence based on physical investigations. As I have before said, our earliest determinations of the successive faunæ depend upon the previous stratigraphical determinations. This I think is acknowledged by Mr. Barrande himself, when he presents to us, as a preliminary work, a section across the centre of Bohemia. With all willingness to accept Mr. Barrande's determination, fortified and sustained as it is by the exhibition of his magnificent work upon the trilobites of these strata, we had not yet the means of parallelizing our own formations with those of Bohemia by the fauna there known. The nearest approach to the type of primordial trilobites was found in those of the Potsdam sandstone of the northwest, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms;* and the prevailing opinion, sanctioned as I have understood by Mr. Barrande, was that the primordial fauna had not been discovered in this country, until the re-discovery of the Paradoxides Harlani, at Braintree, Mass. The fragmentary fossils published in vol. 1, Palæontology of New York, and similar forms of the so-called Taconic System, were justly regarded as insufficient to warrant any conclusions. It then became a question for palæontologists to decide, whether determinations founded on a physical section in a disturbed and difficult region of comparatively small extent, were to be regarded as paramount to determinations founded on examinations, like those of the professors Rogers, extending over a distance in the line of strike of five or six hundred miles; and those of Sir William Logan over nearly as great an extent from Vermont to Gaspé.

It is not possible for me, at this moment, to give the time necessary for a full discussion of this important subject. In presenting these few facts in this form, I am far from doing it in the spirit of cavilling, or as an expression of distrust in any direction. It is plain that the case is not met in Mr. Barrande's plan of successive Trilobitic faunæ; and the facts yet brought out do

* The glabellæ of small trilobites undistinguishable from Conocephalus occur in the Potsdam sandstone near Trempaleau, Wisconsin, on the Mississippi river.

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not serve to clear up the difficulty. It is evident that there is an important and perplexing question to be determined,—one that demands all the wisdom and sagacity of the most earnest inquirers, and one which calls for the application of all our knowledge in stratigraphical geology and in palæontology;—one in which coöperation, good will and forbearance are required from every one, to harmonize the conflicting facts as they are now presented. The occurrence of so many types of the second fauna in the rocks at Point Levi, associated with a smaller number of established primordial types, offers us the alternative of regarding these strata as of the second stage, with the reappearance of primordial types in that era, or of bringing into the primordial zone several genera heretofore regarded as beginning their existence in the second stage: in either case, so far as now appears, conflicting with the scheme of Mr. Barrande in reference to the successive faunæ of Trilobites as established in Bohemia and the rest of Europe.

For myself I can say, that no previously expressed opinion, nor any "*artificial combinations of stratigraphy previously adopted*" by me, shall prevent me from meeting the question fairly and frankly. I have not sought a controversy on this point, but it is quite time that we should all agree that there is something of high interest and importance to be determined in regard to the limitation of the successive faunæ of our older palæozoic rocks.

I am very truly yours, &c.,

JAMES HALL.

Albany, N. Y., January 23, 1861.

ART. XX.—*On a new Lead-Salt, corresponding to Cobalt Yellow;* by S. D. HAYES, of Boston.

IN the course of some investigations on the cobalto-cyanid compounds, I was obliged to use a quantity of cobalt yellow, the pigment discovered by M. Saint Evre in 1852.* All the methods described for preparing this salt are very tedious, so that it became an object to find a more ready means. The best method, which has heretofore been given, is to precipitate a solution of nitrate of cobalt, with an excess of potash; then by passing a current of deutoxyd of nitrogen (NO^2) through the mass, the cobalt yellow is obtained; but the greater part of the NO^2 passes through, without being absorbed; the experiment requires hours; and the amount of salt so obtained is very small.

As the composition of this body is considered doubtful, it occurred to me that it might be made from peroxyd of nitrogen (hyponitric acid, NO^4), and after a few trials, I obtained it by this

* Annal. Ch. Phys., 3d series, xxxviii, 177.

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agent very readily, in large quantities, and found that all the cobalt contained in a solution may thus be converted into cobalt yellow. Two bottles, connected, and supplied with funnel tubes, are about half filled with a solution of nitrate of cobalt, to which potash, slightly in excess, is added. On passing through the solution a brisk current of NO^4, the mass in the first bottle soon changes color, and the pigment begins to fall; by adding small quantities of potash, occasionally, through the funnel tubes, all the cobalt may be removed. The NO^4 is most readily prepared, by allowing a current of NO^2 made from copper and diluted nitric acid, in a small flask, to mix with a current of common air from a gasometer, in a dry empty bottle, before passing into the cobalt solutions. The current of air can be regulated at the gasometer, and the flask for generating NO^2 can be easily removed, and replenished when necessary. A solution of the carbonate of potash may be used, instead of caustic potash, for precipitating the cobalt solutions, with the same result.

A. Stromeyer, when working upon this salt, endeavored to obtain an analogous body with lead; he succeeded in getting a yellow solution, by means of nitrite of potash, and acetic acid, in a solution of lead, but he then added cobalt, which gave a precipitate.*

On treating a solution of nitrate of lead with potash and passing through it a current of NO^4, precisely as in making the cobalt-yellow, I found that all the NO^4 was absorbed, and as the oxyd of lead disappeared, the solution became very yellow; on evaporating, and crystallizing this, I obtained large, yellow, prismatic crystals; nitrate of potash crystallizes at the same time, and if the NO^4 has been passed through the lead oxyd mixture too long, nitrate of lead is formed.

The yellow salt was easily separated and recrystallized. The bases were determined as sulphates, with the following results:

I. 0·7462 grms. pure salt gave 0·4200 grms. sulphate of lead, and 0·0097 grms. lead = 0·3195 grms. oxyd of lead, and 0·2472 grms. sulphate of potash = 0·1335 grms. potash.

II. 1·459 grms. gave 0·6387 grms. oxyd of lead, and 0·2593 grms. potash.

III. 1·0271 grms. gave 0·43745 grms. oxyd of lead, and 0·1881 grms. potash.

The nitrogen was determined as gas; metallic copper reduced from the *fine* oxyd, being used in the combustion tube with a little oxyd at the fore end; the gas was collected, and washed in a small apparatus, then transferred to the eudiometer, where it was measured.

I. 0·1926 grms. salt gave 45·6277 cubic centimeters, nitrogen, temperature 60° C.; pressure 277·5 millimetres = 16·30 c. c., at 0° C. and 760 mm. pressure = 0·2048 grms.

* Ann. Ch. und Pharm., xcvi, 228

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II. 0·1958 grms. gave 16·23 c. c. at 0° C. and 760 mm. pressure = ·0226 grms.

The water was determined by combustions with metallic copper.

I. 0·7834 grms. gave 0·0274 grms. water.
II. 0·9145 grms. gave 0·0314 grms. water.
III. 0·4735 grms. gave 0·0177 grms. water.

These results sum up as follows.

	I.	II.	III.	IV.
Oxyd of lead,	42·81	43·08	42·59	43·22
Potash,	17·90	17·77	18·31	"
Nitrogen,	10·63	"	10·35	"
Water,	3·49	3·43	3·73	"
Oxygen, by difference,	25·16	"	25·02	
	100·00		100·00	

The above analyses correspond to the following calculated formula:

PbO,	111·56	42·98
KO,	47·	18·10
N_2,	28·	10·78
O_5,	64·	24·67
HO,	9·	3·47
	259·56	100·00

As this salt crystallizes out with nitrate of potash, it is of about the same degree of solubility, in either hot or cold water, and the solution may be boiled for some time, without any decomposition: but it is readily decomposed by sulphuric, hydrochloric, or nitric acid, giving off red fumes. With the common reagents, it acts as nitrate of lead, but with a solution of sulphate of cobalt, it gives cobalt yellow, which goes down with the sulphate of lead. It loses its atom of water at 100° C., but if the temperature be raised a few degrees higher, the red fumes are given off abundantly. The crystals are of a bright yellow color, and remain unaltered in the air.

I am not yet prepared to give this salt any decided *rational* formula, but its composition may be expressed in several ways, as below. When $2NO_4$ are passed over 2KO, we get $KONO_5$ and $KONO_3$, two distinct salts, but if $2NO_4$ be passed over CoO and KO, as in the case of cobalt yellow, or over PbO and KO as in this salt, we get only one salt of a double composition which we must write—

$$KONO_3, CoONO_5 \text{ or}$$
$$KONO_3 \text{ or } PbONO_5 + HO$$

But there are objections to this: cobalt yellow is almost or quite insoluble in water. These salts may also be looked upon as double per-oxyds, in which two equivalents of oxygen have been replaced by two equivalents of NO_4; but from the nature of the salts, I hardly think that NO_4 exists in them. How-

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ever, Gmelin describes a salt to which he gives the formula 2PbO, NO_4, Aq,* and we express the composition of these salts quite as well, by writing them thus,

$$KONO_4\ CoONO_4 \text{ or}$$
$$KONO_4, \text{ or } PbONO_4+HO$$

This subject will be pursued, and I hope to get several other salts, which must give some reactions that will lead to the right rational formulæ.

Heidelberg, Baden, Dec. 5th, 1860.

ART. XXI.—*Sketch of the Geology of the Country about the Head-waters of the Missouri and Yellow Stone Rivers;* by Dr. F. V. HAYDEN, Geologist to Capt. Raynolds's Expedition, with an Introductory letter by Capt. W. F. Raynolds, U. S. Topographical Engr.

A. CAPT. RAYNOLDS'S LETTER.

[THE following rapid sketch of the main geological features of the country passed over by the recent expedition to the Head-waters of the Yellow Stone and Missouri rivers, prepared by Dr. F. V. Hayden the Geologist of the Expedition, is submitted for publication by authority of the Honorable Secretary of War.

The district that was examined by the expedition is bounded by the Missouri river on the north and east, by the Platte on the south and by the dividing crest of the Rocky Mountains on the west, and operations were strictly confined to those limits, excepting between the head of Wind river and the Madison fork of the Missouri where the nature of the country was such as to force my division of the party across the main chain of the mountains.

The expedition was in the field for two entire seasons (1859 and 1860) and during about half of the first and the whole of the last season, was divided into two sections or divisions, the first under my immediate control, the second under Lt. Maynadier, U. S. A., the routes travelled over being widely separated so that the amount of labor performed was equal to what would have required three and a half years for a single party; and as operations were all conducted in concert the results must in some respects be more valuable than if obtained by a single party in a longer time.

The total land travel of the different branches of the expedition amounted to nearly five thousand miles independent of having descended in skin and flat boats, the Missouri from Fort Benton to Omaha, N. T., and the Yellow Stone from near the mountains to its mouth.

With the exception of the rivers most of the country had never before been traversed by an exploring party, nor indeed by any whites excepting trappers and not by them for the past fifteen or twenty years.

During the winter months, while the party was stationary on the Platte, Dr. Hayden made a geological examination of the country to the southward along the base of the mountain chain to near Pike's Peak. Dur-

* Handbuch, Bd. 2, s. 142.

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ing the active operations of the party he accompanied that part of the command that was with myself—the geological examinations made by the second division were under the immediate direction of Dr. C. M. Hines of this city.

It is believed that the final results of the expedition will add largely to all branches of the scientific knowledge of the country.

W. F. RAYNOLDS, Capt. Top. Engrs. Comdg.]

Washington, D. C., Jan. 17th, 1861.

B. Dr. Hayden's Sketch.

The observations made during the recent expedition to the head waters of the Missouri and Yellow Stone rivers, under the command of Capt. Wm. F. Raynolds, T. E., have served to extend quite largely our knowledge of the geographical area of the different geological formations already indicated as existing in the far West. I propose in the following paper to present a brief abstract of the leading facts ascertained with a view to their bearing upon the physical geology of the mountain chains. I know that it will be impossible within the limits of a single paper to make every point as clear as could be desired or to use terms in all cases in their usually restricted sense. Much of the country passed over, west of the Black Hills, had never before been explored by scientific men, no maps existed which exhibited its topography with any pretensions to accuracy, and the mountain ranges which were known to exist in that region from information given by traders and trappers were not always laid down in their true geographical localities or with their proper trend, and not until the forthcoming report of Capt. Raynolds, now in course of preparation, appears, can these deficiencies be supplied. Moreover, the wild and broken character of the surface of the country examined, uninhabited except by roving tribes of hostile Indians, precluded the possibility of perfect accuracy in all the minor details, and we can only hope that we have obtained a general idea of the principal geological features of the vast area explored. The rocks observed belong to the different geological periods in the following order:

I. Granite, Stratified Azoic, and Eruptive Rocks,*
II. Potsdam Sandstone, (Silurian,)
III. Carboniferous Rocks, (including Permian, ?)
IV. Red Arenaceous Deposits,
V. Jurassic Beds,
VI. Cretaceous with its divisions,
VII. Tertiary Deposits.

* By granite or graniteid, I mean those unstratified crystalline rocks in the West which hold a lower position than any of the stratified deposits and for the most part possess a uniform character, forming the central portions of the larger mountains; by stratified azoic, a series of non-fossiliferous stratified beds, apparently sedimentary between the granite and Potsdam sandstone, and by eruptive rocks, those which have been melted by volcanic heat and brought to the surface in a more or less fluid condition, at various periods.

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I. Granite, Stratified Azoic, and Eruptive Rocks.

Under the first division of my subject I will take up the mountain elevations as they appeared in their detached portions along our route. It is now well known that the term "Rocky Mountains" is quite general in its application including a vast number of more or less important ranges of mountains, which when examined in detail seem to have been elevated with very little regularity and in many instances to be but slightly connected, but when viewed in the aggregate to present a trend nearly northwest and southeast. Before reaching the main range we find along the eastern slope many detached minor elevations showing the wide geographical area under which the elevating forces acted.

I allude in the first place to the Black Hills, the northern portion of which we examined on our route from Fort Pierre on the Missouri to the Yellow Stone river. These Hills form the most eastern outlier of the Rocky Mountains and would seem to be an independent elevation were it not for a low anticlinal which extends across the plain country southward connecting it with the Laramie Mountains. The central portion is composed of a coarse flesh colored feldspathic granite with a series of metamorphic slates and schists superimposed, and thence upon each side of the axis of elevation, the various fossiliferous formations of this region follow in their order, to the summits of the Cretaceous, the whole being more or less inclined against the granitic rocks. The distance across the granitoid nucleus, is from fifteen to thirty miles and on each side of the crest or axis of elevation we find the corresponding portions of the fossiliferous beds from the Silurian to the summit of the Cretaceous. The evidence therefore, is conclusive that all the unchanged sedimentary strata at a period of comparatively recent date extended continuously over the whole area occupied by the Black Hills. The eruptive rocks reveal themselves at various localities as at Bear Peak, Inyankara Peak, &c. Bear Peak is a protrusion of very compact igneous rocks, almost isolated from the main range of the Black Hills, and Inyankara Peak is for the part composed of pentagonal basaltic columns arranged in a vertical position. There is no evidence however that they were formed by any force independent of that which elevated the entire range of mountains.

The next range that we examined was the Big Horn which is perhaps the most important detached outlier on the eastern side of the main crest of the continent. This seems to trend nearly northwest and southeast, extending into the valley of the Yellow Stone. The nucleus of these mountains is also composed of red feldspathic granite, with a series of stratified azoic rocks; and the unchanged sedimentary strata to the summit of the Cretaceous and including a portion of the Lignite Tertiary can be

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seen in regular sequence outward inclining at greater or less angles. From the observations of Dr. C. M. Hines, who acted as Geologist to the exploring division under Lieut. Maynadier, we know that the corresponding formations occur on the opposite side of the axis of elevation and as we remarked of the Black Hills, we may infer from this fact, that the unchanged sedimentary beds once extended continuously over the whole area occupied by the Big Horn mountains, in a nearly horizontal position sometime during the Tertiary period. As we pass along the northeastern base of the Big Horn mountains southwestward, the ridges of upheaval seem to be presented *en echelon*, the range gradually making a flexure around to the westward. Toward the head waters of Wind River this range as it attaches itself to the main chain of the mountains, changes its lithological characters, no true ancient igneous rocks being seen, but instead, lofty peaks composed of eruptive rocks, presenting every variety of structure from compact basalt to porous lava-like masses.

The Laramie mountains, by which we mean the whole range from the Red Buttes to the Arkansaw, were examined with some care from Red Buttes southward nearly to Pike's Peak. There is a remarkable similarity in the general geological features of all the mountains on the eastern slope. The more lofty elevations as Long's and Pike's Peaks with other ridges and peaks scarcely less lofty than those just mentioned, are composed of the same coarse feldspathic granite before alluded to, but the lower ridges are formed to a great extent of a ferruginous feldspathic granite which easily yields to atmospheric agencies, and the surface of the country is paved with crystals of feldspar in consequence of its decomposition. All along the base and often extending up to the crest of the mountains, we see the outcropping edges of the fossiliferous rocks inclining at greater or less angles, and on crossing over into the Laramie Plains we find the corresponding strata leaning from the opposite side. The granitoid nucleus varies from eight to twenty miles in width. No indications of true eruptive rocks were observed in this range. The Medicine Bow and Sweet Water mountains appear to be of the same character for the most part, but on the east side of the Sweet Water river the evidence of igneous action is shown on a large scale. The ancient volcanic material would seem to have been elevated to a great heighth in but a partially fluid condition and then to have gradually cooled, affecting to a greater or less extent the fossiliferous strata in contact.

Near the junction of the Popo Agie with Wind River, we came in full view of the Wind River mountains which form the dividing crest of the continent, the streams on the one side flowing into the Atlantic, and those on the other into the Pacific. This range is also composed to a large extent of red and gray feldspathic granite with the fossiliferous rocks inclining high

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upon its sides. After passing the sources of Wind River, the mountains appear to be composed entirely of eruptive rocks. Even the three Tetons which raise their summits eleven thousand feet above the ocean level are formed of very compact basaltic rock. The Wasatch and Green River ranges, where we observed them have the same igneous origin and the mountains all along the sources of the different branches of the Columbia exhibit these rocks in their full force. In Pierre's Hole, Jackson's Hole and other valleys surrounded by upheaved ridges, these ancient volcanic rocks seems to have been poured out over the country and to have cooled in layers, giving to vast thicknesses of the rocks the appearance of stratified beds.

The mountains about the sources of the Missouri and Yellow Stone rivers are of eruptive origin and in the valley of the Madison fork of the Missouri are vertical walls of these ancient volcanic rocks one thousand to fifteen hundred feet in height, exhibiting the appearance of regularly stratified deposits dipping at a considerable angle. As we pass down the Madison we find some beds of feldspathic rocks and mica and clay slates beneath the eruptive layers, dipping at the same angle. After passing the divide below the three forks of the Missouri we see a number of partially detached ranges which appear to be of the same igneous character. In the Belt, Highwood mountains and indeed all along the eastern slope in this region we find continual evidence of the outpouring of the fluid material in the form of surface beds or in layers thrust between the fossiliferous strata. These igneous beds thin out rapidly as we recede from the point of effusion. A large number of these centres of protrusion may be seen along the slope of the mountains west of the Judith range. The erupted material sometimes presents a vertical wall three hundred feet high, then suddenly thins out and disappears. The Judith, Bear's Paw and Little Rocky Mountains seem to be composed for the most part of granite and other rocks, with igneous protrusions here and there. I have in a former paper expressed the opinion that the central portions of our mountain ranges are composed of feldspathic granite and to a certain extent this is true in regard to the more eastern outliers, but more recent observations have convinced me that these rocks which I have defined by the term eruptive compose by far the greater portion of the mountain masses of the west.

II. Potsdam Sandstone. (*Silurian.*)

The discovery of this formation in its western extension has already been announced in a former paper.* It was first made known as occurring in the Black Hills and resting upon the upturned or nearly vertical edges of the schists, clay slates and granitoid rocks, and the inference was drawn that the same rocks

* This Jour., [2], xxvi, 276.

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would be found forming an outcropping belt all along the eastern slope of the Rocky Mountains. After leaving the Black Hills we next observed it along the margins of the Big Horn range near the summit, holding the same relative position and exhibiting the same lithological characters. A few thin layers of fine calcareous sandstone were observed filled with fossils characteristic of this period. At the head of LaBonte creek in the Laramie range I noticed a bed resting discordantly upon azoic slates, fifty to one hundred feet in thickness, holding the same position and possessing the same lithological characters which it reveals at other localities. I could discover no fossils in it at this point but I am confident that this bed represents the Potsdam sandstone. The same bed seems to occur all along the mountains from Laramie Peak to Cache la Poudre creek underlying the well-known Carboniferous strata and resting upon the decomposing granitoid rocks, which form the nucleus of the first ridge. This rock (the Potsdam) is more or less changed by heat from beneath, but I was able to trace it continuously from the source of the Chugwater creek to the source of Cache la Poudre, a distance of over one hundred miles. It was also seen along the eastern slope of the Wind River mountains but did not contain any organic remains.

The above facts show very clearly that in its western extension, the primordial zone of Barrande is represented only by a thin bed of sandstone never exceeding one hundred and fifty feet in thickness, and that is seen only in a very narrow outcropping belt near the margins of the mountain crests. The stratified azoic rocks upon which it rests discordantly so far as my observations have extended, never reach a very great thickness in the west.

III. Carboniferous Rocks, (Including Permian?).

On both sides of the divide of the Rocky Mountains, so far as our explorations have extended, a series of calcareous, areno-calcareous and arenaceous beds are seen which we have referred to the Carboniferous epoch. They vary in thickness at different points. Without specifying localities it will be sufficient to remark that all along the margins of any of the mountain elevations in the far West, these rocks are seen in a more or less inclined position.

Sometimes they are not visible for a short distance (as between the Laramie and Platte Rivers, twenty or thirty miles), but it is plain that they have either been removed by erosion, or concealed by more recent deposits. Along the Big Horn mountains there are alternate layers of sandstone, arenaceous and magnesian limestones, many of which show oblique laminæ and other indications that their deposition took place in shallow and perhaps turbulent waters. They are here developed to a thickness of one thousand

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to fifteen hundred feet and incline high upon the sides of the mountains at an angle of 50° to 70°. They contain few fossils but these indicate rocks of the same age as those in the Black Hills. Along the Laramie mountains, from the Red Buttes to Pike's Peak, apparently the same limestones are seen inclining against the sides of the elevated ridges at greater or less angles and on the opposite side of the axis sloping down to the Laramie plains the corresponding strata are seen, though leaning at much smaller angles, usually from 9° to 15°. Along the Sweet Water and Wind River mountains these rocks are highly developed and incline against the sides of the ridges of elevation as heretofore described. The corresponding portions are also seen on the west slope of the main range at the sources of Green and Snake Rivers but not as conspicuously developed, the eruptive rocks predominating. Crossing back over the dividing crest near the sources of the Madison, Jefferson and Gallatin Forks of the Missouri, we find similar limestones largely developed and covering a considerable area on the eastern slope. Near the junction of the three forks and along Smith's or Kamas River we find them reaching a thickness of eight hundred to one thousand feet, often partially changed by contact with igneous rocks beneath. They were also observed around the Judith Mountains and also about the Bear's Paw and Little Rocky Mountains.

Nowhere in the Rocky Mountain range so far as my observations have extended, do the Carboniferous rocks seem to abound in organic remains and the few usually seen are generally found in a bad state of preservation and comprise a limited number of species. The precise period to which these rocks belong, which are so persistent in all disturbed regions, is not positively known, the evidence from organic remains pointing to the age of the Coal measures and sometimes to that of the Lower Carboniferous Period; probably both members of the system occur there.

At the foot of the Big Horn mountains near the head of Powder River, I observed at one locality a series of beds which indicated the presence of Permian rocks. These beds which are composed of cherty magnesian limestone are very much like those already described in northeastern Kansas and contain in great abundance some of the same species of fossils as *Myalina perattenuata* and others. I have also seen similar limestones in other localities but no fossils were detected and though having a Permian appearance they may belong to the upper portion of the Carboniferous.

The evidence is clear in many localities that prior to the deposition of the Red Marls succeeding the supposed Permian, a very great erosion of the surface of the Carboniferous rocks took place. We find, for example, in many localities only a thin representation of the Carboniferous rocks and again a full development, one thousand to fifteen hundred feet in thickness.

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IV. Red Arenaceous Deposits.

Overlying the Carboniferous rocks and equally persistent with them is a series of red arenaceous Marl beds or gypsum-bearing marls which are coëxtensive with the upheaved sedimentary formations along the Rocky Mountains. The largest development of these beds which I have observed, occurs on the northeastern side of the Big Horn mountains and on the west slope of the Wind River mountains near the source of the Gros Ventres Fork of Snake River. From the Red Buttes on the North Platte to Pike's Peak these beds are often removed by erosion or concealed by superficial deposits, but their appearance in numerous places shows very clearly that beneath the surface they occupy a considerable area throughout the country bordering the mountain ranges, possibly extending entirely over the eastern slope. Passing over into the Laramie Plains we find that the red marls constitute the surface formation of the plain country. It has also been shown from Mr. H. Engelmann's explorations that these beds are revealed along the Wasatch Mountains, even south of Lake Utah, furnishing undoubted evidence that they belong to the same great deposit. The fact also that one thousand to fifteen hundred feet of red arenaceous beds are seen near the sources of Green River, leads to the inference that they continue southward far down the Green River valley to that portion which takes the name of Colorado, and are in fact a continuation of the extensive red deposits, described by various explorers in New Mexico.

These red beds are also seen under similar circumstances highly developed along the mountains at the sources of the Missouri. There seems to be a change in the lithological characters below the Gate of the mountains, the peculiar red deposits disappearing for the most part and a series of irregular layers of siliceous limestone with a reddish tinge, and with oblique laminæ, ripple mark and other indications of shallow water deposition. It is through these layers of rock that the Missouri River cuts its way from the foot of the mountains to the mouth of High Wood creek, about ten miles below the falls. They are also distinctly revealed around the Judith mountains. Along the Big Horn mountains thick layers of gypsum occur, but the gypsum beds are by no means co-extensive with the red deposits, and indeed are present in but few localities. Near the head of Powder River the aggregate thickness of the gypsum strata is about one hundred feet while near the source of Snake River there is a thickness from fifty to eighty feet. It also occurs to a considerable extent at the foot of the mountains, on La Bonte creek, a branch of the North Platte.

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V. Jurassic Rocks.

These rocks are everywhere revealed, overlying the red deposits just mentioned and possessing an equal geographical extension. Their fullest development and most fossiliferous condition seems to be along the margins of the Black Hills where they have furnished the most satisfactory evidence of their age. Along the northeastern slope of the Big Horn mountains, this group of rocks presents its usual appearance of grey and whitish calcareous and arenaceous layers, with indurated somewhat variegated beds of more or less laminated marls, containing in great abundance *Belemnites densus, Pentacrinus asteriscus*, a new species of *Ostrea*, *Pecten*, &c.

At Red Buttes we find a fair development of these beds with the same fossils, but as we proceed southward toward Long's Peak, the intercalated laminated marls disappear and the whole formation seems to be reduced to a thickness of fifty to one hundred feet, with very few fossils. Along the southwest side of the Big Horn mountains and the northeast side of the Wind River mountains we have a thickness of Jurassic rocks from eight hundred to one thousand feet containing organic remains in the greatest abundance. Crossing the Wind River mountains we observed the strata corresponding to those upon the eastern side with *B. densus*, *Ostrea*, &c. Returning to the eastern slope at the sources of the Missouri we see occasional indications of their existence, but not so conspicuous as to be readily identified. The age of this group of rocks may be now considered as thoroughly established, so great a number of fossils which appear to be of undoubted Jurassic forms have been obtained.

I have remarked that the older fossiliferous beds doubtless pass beneath the more recent Cretaceous and Tertiary deposits and occupy a greater or less area underneath the prairie country east of the 'divide' of the Rocky Mountains. I have made this inference from the fact that where any elevations occur the complete series of fossiliferous beds are exposed around the axis of upheaval. That I may be not misunderstood by those geologists who have colored large areas Triassic and Jurassic on geological maps of the West, I would say, that I have never seen any of the older fossiliferous rocks from the Potsdam to the Jurassic inclusive, exposed except in narrow outcropping belts around the margins of the mountain elevations. The Carboniferous rocks occupy a belt from one to two miles wide, and the red arenaceous deposits are exposed over about the same area, while the Jurassic form a zone never more than one-fourth of a mile to three miles in width.

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VI. Cretaceous Rocks with Subdivisions.*

The various subdivisions of the Cretaceous group in the West were observed at numerous localities. The strata in many places occupy large geographical areas, holding a horizontal position, in others forming a belt or zone of greater or less width around the mountain elevations. No. 1 is a well marked and distinct division along the Missouri River from Desoto to a point above the mouth of the Big Sioux River in the eastern portions of Kansas and Nebraska and in the south and southwest. But when we come into the vicinity of the mountain ranges in the northwest its typical form is wanting, and apparently an increased development of No. 2 only is seen. Along the Big Horn mountains, No. 2 is eight hundred to one thousand feet in thickness, composed of black, plastic clay with several layers of gray and yellowish calcareous sandstones ten to fifty feet in thickness. Along the Laramie and Wind River mountains the same characters are shown. After leaving the Missouri near the mouth of the Niobrara river No. 3 is never seen presenting its typical marly character. In the vicinity of the Black Hills we saw a series of beds composed of alternate thin layers of arenaceous and argillaceous sediments with *Ostrea congesta* and *Inoceramus problematicus* which may possibly represent No. 3. Along the Big Horn mountains and from Red Buttes to Cache la Poudre creek the same fossils were often found and some other indications of its existence, but no well marked typical beds were seen. It is now well-known that *O. congesta* and *I. problematicus*, range down into No. 2, so that No. 3 in the west and southwest may give place to an increased development of No. 2. Nos. 4 and 5 are largely developed every where, when not concealed by the overlying Tertiary deposits, especially along the Laramie mountains and in the valley of Cache la Poudre. In the Valley of Wind River all the Cretaceous rocks down to No. 2, appear to have been removed by erosion prior to the deposition of the Tertiary Beds, and the characteristic fossils of No. 2, are quite abundant. As we pass over mountains, we have inclining from the western slope, six to eight hundred feet of alternations of black plastic clays, arenaceous marls and beds of sandstones and limestone with a few seams of Carbonaceous matter passing up into calcareous and arenaceous compact rocks. In some arenaceous limestones near the middle of the series and extending upward, quite abundant fossils were observed, among them a large *Inoceramus*, two species of *Ostrea*, a large *Pinna*, four inches in length, a *Cardium* and a number of undetermined species with fragments of silicified wood. The general dip of these rocks is about 20°. These

* The Cretaceous rocks of the West have been divided into five formations, numbered 1, 2, 3, &c. A more careful study of No. 1 ? may render it necessary to make other divisions.

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well marked Cretaceous beds pass up quite imperceptibly into an enormous thickness of Lignite Tertiary. Passing over the dividing crest to the head waters of the Missouri, we did not observe any indications of Cretaceous rocks until we had descended below the three forks, where we find traces left after erosion. They do not reveal themselves conspicuously until we arrive within twenty or thirty miles of Fort Benton where the black plastic clay begins to overlap the Jurassic rocks with its characteristic fossils, and on reaching Fort Benton the plastic clay is quite homogeneous and is developed to a thickness of eight hundred feet. As we proceed toward the mouth of the Judith River and near the Judith mountains we find quite thick beds of concretionary sandstone which form the "Stone Walls," "Citadel," &c. It is from these beds that we have obtained a group of fossils which we have referred provisionally to No. 1, but which seem to be specifically distinct from all others in the West. It may be that when this group of beds now referred to Nos. 1 and 2, comprising a thickness of fifteen hundred to two thousand feet in this region are more carefully studied that several subdivisions will be made, having equal importance with the others. During the past season our route led us along the 'divide' between the Missouri and Yellow Stone rivers south of the Judith mountains, so that we passed outside of any good exposures of No. 1, as well as beyond the limits of the estuary beds at the mouth of the Judith. We must await a more thorough and detailed exploration of this region before we can state with entire confidence the succession of the beds.

VII. Tertiary Deposits.

In speaking of the Tertiary deposits of the Northwest, so far as known at the present time I propose to separate them into four divisions which will be sufficient for our immediate purposes. 1st, Estuary Deposits. 2nd, True Lignite Beds. 3rd, Wind River Valley Deposits. 4th, White River Tertiary Deposits.

The estuary deposits, of which the Judith basin may be regarded as the type, are quite remarkable and of a most interesting character. Opinions of a somewhat conflicting nature have been entertained in regard to them, owing to the peculiar character of the organic remains, but recent observations have convinced me that they are all of Tertiary age and that they are quite widely distributed throughout the far West. The lithological characters of the Judith deposit have already been sufficiently described and it has yielded many important fossils. A thin series of beds is also found near the sources of the Moreau, Grand and Cannon Ball rivers, and at the mouth of the Big Horn river we have a group of beds eight hundred to one thousand feet in thickness with fossils of the same character as those

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occurring at the mouth of the Judith. The researches of Mr. H. Engelmann, in Utah, have also established the existence of an estuary deposit in the country bordering upon Green river,—scarcely less interesting than that of the Judith. These deposits pass up into the true lignite beds without any perceptible line of separation gradually losing their estuary character and ever after containing only land and freshwater shells. The lignite strata are chiefly remarkable for yielding in the greatest abundance, finely preserved vegetable remains. A few fragments of leaves of Dicotyledonous trees and silicified wood, with very impure lignite beds, are formed in some of the estuary deposits but no groups to indicate the great luxuriance of vegetation which must have existed during the accumulation of the lignite strata.

The geographical extension of the lignite deposits of the West is now a matter of the highest interest, and from what is already known, I am convinced that they will yet be found to cover a greater or less area on both sides of the main 'divide' of the Rocky Mountains, from the Arctic Sea to the Isthmus of Darien. The estuary and lignite beds seem also to have partaken equally with the older fossiliferous rocks, of the influence which elevated the mountain chains. Along the Laramie mountains, and from the Red Buttes to the 'divide' between Platte and Wind rivers along the Big Horn mountains the strata incline at very high angles 40° to 80° and in some instances are very nearly vertical. The true lignite strata seem to conform to the older fossiliferous rocks and to have been disturbed by the same influences that elevated the mountain ranges in the vicinity. These Tertiary beds extend over all the plain country to the north, and east of the Laramie mountains, far to the northward, beyond the limits of our explorations. Crossing the Wind River mountains, we find them largely developed high upon the western slope, dipping at a high angle, from the Wind River range on the one side, and the Wasatch and Green River mountains on the other.

Throughout the Wind River valley is a series of beds of great thickness which seem to be intermediate in their character between the true lignite beds and the White River Tertiary deposits. We first observed them gently inclined near Willow Springs on the North Platte and thence westward toward the Sweet Water mountains, and near the 'divide' between the North Platte and Wind River they reach a thickness of four hundred feet. From this 'divide' throughout the Wind River valley they occupy the greater portion of the country and though inclining in the same direction with the older strata the beds do not dip more than 1° to 5°. They differ from the other deposits in the great predominance of arenaceous sediments and in the absence of vegetable remains, but they contain fragments of turtles and

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numerous fresh water and land shells of the genera *Helix*, *Planorbis*, *Vivipara*, etc. The entire thickness of these deposits may be estimated at from fifteen hundred to two thousand feet. From the fact that these deposits do not conform to the true lignite beds and that detached portions are seen lying upon the sides of the mountains but slightly inclined, while the corresponding beds are shown in the valley below, we infer that they were accumulated long before the mountains were raised to their present height or perhaps during the gradual process of elevation. This is especially shown at the upper end of the Wind River valley. Passing over the Wind River mountains we again see them holding the same position on the western slope and possessing the same lithological characters. While the lignite beds on the west side of the 'divide' incline at a large angle, the more recent beds although in some places occupying the very crest of the mountains, seldom incline more than 3 to 5 degrees.

The most interesting additional facts which we have obtained in regard to the White River Tertiary beds, are their geographical extension and the evidence of their age in relation to the lignite deposits. We can now show beyond a doubt that the former must have been accumulated long since the latter. We have ascertained that they extend southward along the Laramie Mountains to Willow Springs within ten miles of Cache la Poudre, that they also extend up the North Platte to the Box Elder creek, and even beyond are small outliers, showing that much has been removed by erosion. Passing over into the Laramie Plains we find at the source of the Box Elder and extending over to the head of Bates Fork a large development of this Tertiary and it also reaches far westward to the Medicine Bow mountains. We also know from the observations of Dr. Hines that it occupies a considerable area among the Sweet Water mountains extending over into the Green River valley. We have along the North Platte the overlapping of the White River beds upon the lignite strata, thus affording the evidence of superposition for their relative age. The same fact was noticed between the north fork of the Shyenne and the head of Cherry creek where beds of marl and limestone containing *Planorbis*, *Limnea*, etc., the same as are seen in the Bad Lands proper, repose upon true lignite Tertiary strata. Again, while the White River beds hold for the most part a horizontal position, those of the lignite Tertiary are often much disturbed. Near the Black Hills the former seem to have been elevated to a considerable heighth by the upheaval of the mountains, but they do not in any case incline more than 1° while north of the Black Hills the lignite beds dip 5° to 10°. Along the Platte I have seen the former inclining 5°, especially on La Bonte creek and about

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fifteen miles east of the mouth of that creek. Often the beds seem to have been raised up several hundred feet above their original position, without inclination, resting upon the upturned edges of the lignite beds which we have before observed, partook equally of the disturbing influences which have given so great an inclination to the older fossiliferous rocks. Along the Big Horn mountains and the North Platte the lignite beds sometimes incline from the foot of the mountains 80° and often the influence of the elevatory power has affected them far out into the plain country.

In the above accounts of the Tertiary deposits of the West we have shown that the older members are clearly separated into four divisions exclusive of the Pliocene deposits of the Niobrara. Let us examine the evidence in regard to the age of these deposits. If we study the upper portions of Cretaceous formation No. 5 when not removed by the erosive power of water to any great extent, we then observe from the time we pass from No. 4 to No. 5 a gradual change in the sediments and other indications of a slow approach to shallow water, arenaceous sediments begin to take the place of argillaceous so that we have alternate thin layers of sand and clay, the sand continuing to increase until the upper part becomes a yellow ferruginous, coarse sandstone with most conspicuous examples of ripple-mark and oblique laminæ. As the waters of the Cretaceous sea were gradually receding, toward the Atlantic on the one side, and toward the Pacific on the other, remnants were left in the form of lakes, estuaries, etc., which now afford us the last indications of marine and brackish water deposits in the central portions of the West. In these deposits we have first a mingling of brackish and fresh-water forms, gradually passing up to pure fresh-water and terrestrial species, with no return to the marine condition again.

In the upper part of the Cretaceous formation No. 5, on the Moreau, we find the *Ostrea subtrigonalis*, and in the Judith deposits a form occurs in the greatest abundance which is undistinguishable from it.

We have also mentioned the fact that the fossils of upper part No. 5 seem to have existed upon the verge of the Tertiary period, that they sometimes present peculiar forms more closely allied to Tertiary types than Cretaceous and were it not for the presence of the genera *Baculites, Ammonites, Inoceramus*, etc., which are every where supposed to have become extinct at the close of the Cretaceous epoch, we would be in doubt whether to pronounce them Tertiary or Cretaceous. These facts would seem to indicate a foreshadowing of the Tertiary era and that the transition from one great period to the other was gradual and quiet, the change in the physical conditions being ultimately sufficient to

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destroy the Cretaceous fauna and bring into existence that of the Tertiary. Again, in numerous localities where No. 5 is fully developed and a large thickness of Tertiary deposits is superimposed, so that near some of the mountain elevations I have found it difficult to draw the line of separation, no apparent physical break occurring in the sediments.

Will not these statements go far to show that the estuary deposits ushered in the dawn of the Tertiary epoch and induce the belief that they belong to the first part or Eocene period? This point is an important one to establish, on account of its bearing upon the history of the physical development of our western continent.

The estuary deposits soon lose their marine and brackish character and gradually pass up into the true Lignite strata, of purely freshwater origin, thence by a slight discordancy into the Wind River valley beds, which give evidence of being an intermediate deposit between the true lignite and White river Tertiary beds. Then come the White river bone beds which pass up into the Pliocene of the Niobrara by a slight physical break, and the latter are lost in the Yellow Marl or Lacs deposits. I have estimated the entire thickness of Tertiary rocks in the Northwest at from five to six thousand feet, and their interest will be appreciated when I venture to suggest that by thorough investigation they will doubtless reveal in a most remarkably clear manner the history of the physical growth and development, step by step, of the central portion of this continent. I shall treat this subject more fully in a future paper, and would refer to the forthcoming Report of Capt. Raynolds for the details of the facts sustaining my opinions.

We have no evidence, so far as I know, of long continued deep-water deposits in the west, until far up in the Cretaceous period. If we examine the Potsdam sandstone we shall find that where it reaches its greatest force, the lower portion is composed of an aggregation of quartz pebbles cemented with siliceous matter, and as we pass upward we find it arranged in thin layers quite compact with fucoidal markings, ripple-mark, &c. Everywhere are most abundant examples of oblique laminæ of deposit, and ripple and wave-markings—evidences of shallow waters.

During the long period that elapsed between the deposition of the earliest part of the Silurian epoch and the commencement of the Carboniferous, we have reason to believe that dry land prevailed over a large portion of the west. The Carboniferous epoch commences with thin layers of arenaceous deposits gradually passing up into homogeneous siliceous and calcareous beds. The latter are never more than from twenty to fifty feet in thickness, and then the arenaceous sediments begin again to predominate and all the proofs of shallow as well as turbulent waters are shown. We then pass up through the red arenaceous de-

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posits and Jurassic beds, and find no rocks that indicate deep water deposition. Cretaceous formation No. 1 commences in many places with a considerable thickness of an aggregation of water-worn pebbles passing up into thin alternate layers of arenaceous and argillaceous sediments with thick beds of sandstone with ripple markings and oblique laminæ, then gradually ceases in No. 2 and through Nos. 2, 3 and 4, the sediments indicate that they were accumulated in comparatively deep and quiet waters. No. 2 is a black plastic clay, No. 3 grey marl, and No. 4 a dark indurated sometimes laminated clay with many calcareous concretions. In No. 5 we gradually approach indications of shallow water until dry land appears, as already stated.

It will not be possible at this time to mention in detail all the oscillations of surface and other physical changes to which we have reason for supposing the country was subjected during all these periods. It is sufficient for our present purpose to show that except during the middle Cretaceous epoch no long continued periods of quiet water prevailed in these ancient western seas.

The evidence appears to me to point to the conclusion that a much milder climate prevailed throughout the western portions of our continent, during a greater part of the Tertiary period than that which exists in the same latitudes at the present time. The organic remains appear to indicate a subtropical climate or one similar to that of our Gulf States. Near the close of the Cretaceous epoch the waters of the great Cretaceous sea receded toward the present position of the Atlantic on the one side and toward that of the Pacific on the other, leaving large areas in the central portions of the west, dry land. These areas were of course proximity to the sea and comparatively but slightly elevated above the ocean waters. In regard to the Mollusca which have been found quite abundantly entombed in the lignite-bearing strata, it is an interesting fact that the most nearly allied living representatives of many of these species are now found inhabiting the streams of Southern Africa, Asia, China and Siam, apparently indicating the existence of a tropical climate in these latitudes at as late a period as the Tertiary epoch.*

Again, the luxuriance of the flora which has been so perfectly preserved in the lignite strata of the West point to the same conclusion. It is true that until recently no species have been found which belong exclusively to a tropical vegetation, but during our last expedition we obtained a species of true fan palm, very closely allied to *Sabal lamonis*, figured by Dr. Heer in his "Flora Tertiaria Helvetiæ." "The most northern limit of palms is that of *Chamærops palmetto*, in North America in lat. 34°–36°, and of *Chamærops humilis* in Europe, near Nice, in 43°–44° N.

* See Memoir by F. B. Meek and F. V. Hayden, in Proc. Pa. Acad., June, 1856.

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lat."* The true palms of our present day are considered as having their native land within the tropics. That this or a similar condition of climate continued throughout the accumulation of the Wind River valley deposits may be inferred from their Molluscan remains which are more nearly allied to tropical forms.

Again, we have in the West, as before mentioned, a vast area occupied by the lignite-bearing strata. There are from thirty to fifty beds of lignite varying in thickness from one inch to seven feet. Over all this vast area there are at the present time no large forests, no timber except that which skirts the streams. We now know that during the Tertiary period vast forests of timber must have covered many portions of the West from the abundance and variety of the vegetable remains preserved in the rocks. Silicified trunks of trees, fifty to one hundred feet in length and two to four feet in diameter, and stumps which indicate gigantic forest trees occur abundantly over hundreds of square miles along the Missouri and Yellow Stone rivers. Prof. Henry and other meteorologists have arrived at the conclusion from a vast number of well authenticated facts that the absence of forest trees on the great prairies of the far west is due to the want of moisture which is well known to prevail all along the eastern slope of the Rocky Mountains. The prevailing winds are now known to come from the west, and as the currents of air ladened with moisture from the Pacific ascend the western slope of the mountains, become condensed and deposit their burdens for the most part before reaching the eastern slope.

Prof. Henry, in his paper on Climatology contributed to the Patent Office Report for 1856, says: "the return westerly current, sweeping over the Pacific Ocean, and consequently charged with moisture, will impinge on the Coast range of mountains of Oregon and California, and, in ascending its slopes, deposit moisture on the western declivity, giving fertility and a healthful climate to a narrow strip of country bordering on the ocean, and sterility to the eastern slope. All the moisture however will not be deposited in the passage over the first range, but a portion will be precipitated on the western side of the next, until it reaches the eastern elevated ridge of the Rocky Mountain system, when, we think, it will be nearly if not quite exhausted." We are now supposing that the climatic conditions, winds, currents of air, &c., did not differ to any great extent during the Tertiary epoch from those which prevail in the same latitudes at the present day. We therefore venture the suggestion that up to the time of the accumulation of the middle Tertiary deposits the lofty barrier of the Rocky Mountains did not exist.

* Lindley's Vegetable Kingdom, p. 136.

Washington, D. C., January 20, 1861.

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ART. XXII.—*Remarks on the Atomic Weights of the Elements;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy in New York.

IN the present communication I shall endeavor to show that if the atomic weights of oxygen, sulphur and carbon are taken, respectively, as 16, 32 and 12, those of a majority of the other elements must be doubled. I do not at present adopt the view in question; my object is simply to point out the logical consistency of the change. For the sake of convenience and precision of language I shall employ the terms atom, molecule and equivalent, in the sense in which they are understood by the chemists of the new or unitary school.* An atom of any element is the least quantity of that element which can exist in combination: a molecule is the least quantity which can exist in the free state. The definitions of atomic and molecular weights flow at once from those of atom and molecule. The equivalents of bodies are the relative quantities which replace each other in actual or ideal substitutions; they may correspond to atoms or to molecules, or may bear a simple numerical relation to either of these. The atomic weights of carbon, oxygen and sulphur are now generally considered to be respectively 12, 16 and 32, chiefly upon the following grounds:

1. In all volatile organic compounds the constitution of which has been accurately determined, the number of atoms of these elements is always even, if we consider the weights of the atoms to be respectively 6, 8 and 16. Provided that all such compounds are assumed to correspond to 2 vols. of vapor (H=1).

2. Purely chemical considerations appear to show that in organic compounds, independently of any assumption as to vapor-volumes, the number of atoms of carbon, oxygen and sulphur is always even.

3. When oxygen or sulphur replace hydrogen in organic compounds, 2 units of weight of hydrogen are replaced by 16 of oxygen or 32 of sulphur; 4 units of hydrogen by 32 of oxygen, and so on; in no case is one unit of weight of hydrogen replaced by 8 of oxygen.

4. The least quantity of oxygen or sulphur set free in any reaction is either 32 or 64, or is some multiple of 32 or 64. In like manner the least quantity of oxygen or sulphur which reacts with any compound body is a multiple of 16 or 32 by an even number.

The assumption is now generally made that the molecules of all substances in the gaseous state occupy the same volume:

* See for example Kekulé, Lehrbuch der Organischen Chemie, i, 97, Erlangen, 1859.

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from this it follows that in the greater number of cases two atoms unite to form one gaseous molecule. The difficulty which formerly existed in the case of sulphur has been completely removed by the researches of Deville and Troost, and of Bineau, who have shown that the volume occupied by 16 parts of sulphur in the form of perfect gas is $\frac{1}{2}$, and not $\frac{1}{8}$ of that occupied by 1 part by weight of hydrogen. In the case of those substances the vapor-densities of which correspond to *four* volumes, it appears probable that decomposition into two 2-volume molecules occurs, so that the observed vapor-densities are the sums of the densities of the constituent molecules. Thus sal-ammoniac* in the form of vapor is HCl and NH_3, these constituents recombining at a lower temperatute to NH_4Cl. In this manner, among others Kopp† and Hofmann‡ have shown that it is unnecessary to admit the existence of 3-volume, 4-volume and 6-volume vapors. There exists however at least one exception to the law now generally admitted that, in the case of the elements, one molecule consists of two associated atoms. The vapor-density of phosphorus, even at a temperature of 1040° C., corresponds to $\frac{1}{2}$ vol., the atomic weight being taken as 31. Since sulphur, which is less volatile than phosphorus, is a perfect gas even at 860°, we cannot admit that the case is otherwise with phosphorus, or reasonably suppose that the vapor-density would correspond to one volume if determined at a still higher temperature. We must therefore admit that the molecule of phosphorus corresponding to 2 vols. of vapor contains 4 atoms, and not 2 like that of nitrogen, while nothing is more certain than that the atomic weights of phosphorus and nitrogen are respectively 31 and 14. In like manner the vapor-density of arsenic appears also to correspond to $\frac{1}{2}$ volume only, though it has not yet been determined at temperatures very far above the boiling point.

If now we admit that the molecules of all substances occupy 2 vols. in the gaseous state, and if the reasoning which has led chemists to double the old atomic weights of carbon, oxygen, sulphur, &c., be correct, it follows that the atomic weights of the greater number of the elements must be doubled. For we find:—

1. That nearly all volatile inorganic oxyds, chlorids, oxychlorids &c. contain in 2 vols. of vapor (H=1) two or four received equivalents of metal or radical. Thus the compounds whose formulas are now usually written $SiCl_2$, $TiCl_2$, ZCl_2, $SnCl_2$,

* Deville and Troost have shown that sal-ammoniac corresponds to 4 vols. of vapor even at a temperature of 1040° C. At this temperature ammonia must be resolved into its elements, and its vapor-density ought to correspond to 6 vols. instead of 4. The explanation in the text is therefore not applicable to all cases. Comptes Rendus, xlix, 239.

† Ann. Chemie und Pharmacie, cv, 390.

‡ Comptes Rendus, xlix, 781.

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$HgCl$, Hg_2Cl, $HgBr$, Hg_2Br_2, Fe_2Cl_3, Al_2Cl_3, Al_2I_3, Al_2Br_3, CrO_2Cl, must be written Si_2Cl_4, Ti_2Cl_4, Z_2Cl_4, Sn_2Cl_4, Hg_2Cl_2, Hg_4Cl_2, Hg_2Br_2, Hg_2I_2, Fe_4Cl_6, Al_4Cl_6, Al_4I_6, Al_4Br_6, $Cr_2O_4Cl_2$, in order to correspond to 2 vols. of vapor.

2. All volatile metals and metallic oxyds contain two or four received equivalents in 2 vols. of vapor. Thus the vapor-densities of mercury and cadmium represent the molecular weights Hg_2 and Cd_2. Arsenous and osmic acids correspond in the form of vapor to the formulas As_2O_6 and Os_2O_8.

3. All volatile compounds of metals with organic radicals contain an even number of equivalents of metal in 2 vols. of vapor, excepting only those in which triatomic metals occur. Thus we have corresponding to 2 vols. of vapor the formulas:—

$$\left.\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right\}Zn_2,\quad \left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}Zn_2,\quad \left\{C_2H_3\right\}_4Sn_2,\quad \left\{C_4H_5\right\}_4Sn_2,$$

$$\left.\begin{matrix}(C_2H_3)_2\\(C_4H_5)_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_2\\Cl_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_2\\Br_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_3\\Br\end{matrix}\right\}Sn_2,$$

$$\left.\begin{matrix}(C_4H_5)_3\\Cl\end{matrix}\right\}Sn_2.$$

4. The volatile compounds of the triatomic radicals, nitrogen, phosphorus, arsenic, antimony, bismuth and boron, contain in 2 vols. of vapor only one received atomic weight of the radical. Thus we have the compounds:—

NH_3, PCl_3, $AsCl_3$, $SbCl_3$, $BiCl_3$, BCl_3, $P(C_4H_5)_3$, $As(C_4H_5)_3$, $Sb(C_4H_5)_3$, $B(C_4H_5)_3$, $BO_3\,3C_4H_5O$, &c. &c.

To this there are exceptions. Thus we have corresponding to 2 vols. the formulas:—

$$As_2O_6,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2O_2,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2S_2.$$

5. The specific heats of the atoms of nearly all the elements are equal if the molecule is in each case referred to 2 vols. of vapor.*

If now we consider it proved from the above considerations that the molecular weights of carbon, silicon, tin, titanium and zirconium, correspond in the gaseous form to 2 vols., and that these elements are tetratomic, it follows from analogy that certain other elements are also tetratomic, and we have the group:—

Carbon,	12	1·68	Lead,	208	6·52
Silicon,	28	—	Palladium,	108	6·40
Zirconium,	44	—	Rhodium,	102	5·62
Titanium,	48	—	Ruthenium,	106	—
Niobium,	96	—	Platinum,	198	6·40
Tantalum,	136	—	Iridium,	196	7·00
Tin,	116	6·52	Osmium,	194	5·92

* The only exception to this law occurs in the case of carbon, and cannot at present be explained.

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The first column of numbers giving the atomic weights, the second the atomic heats or the products of the atomic weights into the specific heats. It is possible that thorium belongs to the tetratomic group, as thoria appears to be ismorphous with stannic acid, Sn_2O_4. Lead is placed in this group from the analogy of the compounds which it forms with ethyl, methyl, &c. to stannethyl, &c.: it appears however like tin, palladium, ruthenium, platinum, rhodium, iridium and osmium to be also diatomic; the so-called protoxyds having the formulas Pb_2O_2, Sn_2O_2, &c. For similar reasons we admit the existence of 6 triatomic elements, namely:—

Nitrogen,	14	—	Antimony,	120	6·11
Phosphorus,	31	5·85	Bismuth,	208	6·41
Arsenic,	75	6·10	Boron,	11	—

The diatomic elements, according to the reasoning above mentioned, will be 30 in number, and may be arranged in natural families, as follows:—

Oxygen,	16	—	Iron,	56	6·38
Sulphur,	32	6·48	Manganese,	54	—
Selenium,	80	6·08	Cobalt,	60	6·42
Tellurium,	128	6·08	Nickel,	58	6·28
			Chromium,	52	—
Magnesium,	24	—	Aluminum,	27·5	5·88
Calcium,	40	—	Zinc,	65	6·24
Strontium,	88	—	Cadmium,	112	6·36
Barium,	136	—	Copper.	63	6·04
			Uranium,	120	—
Cerium,	92	—	Mercury,	200	6·40
Lanthanum,	94	—			
Didymium,	96	—	Molybdenum,	96	6·91
Yttrium,	—	—	Tungsten,	184	6·67
Erbium,	—	—	Vanadium, ?	138	—
Terbium,	—	—			
Glucinum,	10	—			
Thorium, ?	118	—			

This classification into natural families appears to me to represent the present state of our knowledge, though the position of several elements must be regarded as doubtful.* The monatomic elements are only 10 in number; they may be arranged in three groups:

Chlorine,	35·5	—	Hydrogen,	1	—	Silver,	108	6·16
Bromine,	80	6·74	Lithium,	7	—	Gold,	197	6·38
Iodine,	127	6·88	Sodium,	23	6·71			
Fluorine,	19	—	Potassium,	39	6·60			

* There is reason to believe that vanadium belongs with boron to the nitrogen group.

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It is however to be remarked that, of the other elements, at least two, namely copper and mercury, are monatomic in certain combinations, as for example, in Cu_2Cl and Hg_2Cl. It is true that we may write these formulas Cu_4Cl_2 and Hg_4Cl_2, in which case we have two additional diatomic forms of copper and mercury with the atomic weights 126 and 400 respectively. This mode of viewing the subject obliges us to admit atomic heats represented nearly by the number 12, or twice as high as in the case of the other elements, and appears therefore less simple than that first stated.

In like manner all the elements belonging to the tetratomic group which form protoxyds, &c., may be regarded as tetratomic and diatomic; this will add at least eight to the number of diatomic elements. Finally, in the sesquioxyds and similar compounds two received atoms of iron, manganese, chromium, aluminum, &c., must be regarded as forming a single triatomic atom. Limpricht* and Frankland† admit the existence of pentatomic elements, including the nitrogen group in this class, but this view is not generally adopted, and in the present state of our knowledge a primary division of the 60 elements into four classes, the monatomic, diatomic, triatomic and tetratomic elements, appears to be sufficient.

From the above it appears that of the 60 elements now known to chemists, the received atomic weights of 50 at least must be doubled, if we admit the correctness of the reasoning which has led many chemists at the present day to double the atomic weights of carbon, oxygen and sulphur. Wanklyn‡ and Wurtz§ have already suggested the propriety of doubling the equivalents of zinc and tin, and by analogy, of several other metals, while Cannizzaro‖ has adduced the specific heats of the atoms with other arguments in favor of the same change. Wurtz compares oxyd of zinc Zn_2O_2, with oxyd of ethylene $(C_4H_4)O_2$; the hydrate of oxyd of zinc will then correspond to glycol, $\left.\begin{matrix}Zn_2\\H_2\end{matrix}\right\}O_4$. In the same way we may consider hydrate of sesquioxyd of iron as corresponding to glycerine, $\left.\begin{matrix}\overset{\prime\prime\prime}{Fe}_2\\H_3\end{matrix}\right\}O_6$ to $\left.\begin{matrix}\overset{\prime\prime\prime}{C}_6H_5\\H_3\end{matrix}\right\}O_6$, Fe_2 being here triatomic.

Should the further progress of the science show that the views above mentioned are the most simple and consistent expression

* Limpricht. Lehrbuch der Organischen Chemie, 1te Abth., 8.

† Quarterly Journal of the Chemical Society, vol. xiii, Nos. 2 and 3.

‡ The same, vol. xiii, p. 124.

§ Ann. de Chimie et de Physique, lx, 239, and Repertoire de Chimie pure, ii, 405.

‖ Il nuovo Cimento, vii, 321. I have not seen the original paper and quote at second hand from the Jahresbericht of Kopp and Will for 1858, p. 12.

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of all the facts, it will be desirable to return to the notation of Berzelius slightly modified, that is to say, it will be better to halve the atomic weights of hydrogen and the other monatomic and triatomic elements, and denote the atomic weights of carbon, oxygen, sulphur, zinc, &c., by the numbers 6, 8, 16, 32,5, &c., respectively. In this manner while the formulas are written with precisely the notation of the new school, the numbers actually employed in the great majority of calculations will be those which have been sanctioned by longest usage, and which are most convenient for practical purposes. The atomic weights of hydrogen, chlorine, potassium, and the other monatomic elements, will be in each case one half of the old equivalent, while the molecular weights will correspond with the old equivalents. Thus we shall have:—

Hydrogen,	½	1	Oxygen,	8	16
Chlorine,	17·75	35·5	Carbon,	6	12
Bromine,	40	80	Zinc,	32·5	65
Potassium,	19·5	39	Iron,	28	56
Nitrogen,	7	14	&c. &c.		

in which table the first column gives the atomic and the second the molecular weights.

The formula of water thus becomes H_2O and its atomic weight 9; caustic potash is $\left.\begin{matrix}K\\H\end{matrix}\right\}O$ and its atomic weight 28; oxyd of zinc will be ZnO and its atomic weight 40·5; chlorhydric acid will be HCl and its atomic weight 18·25. The dashed symbols $\dot{H}$, $\dot{Cl}$, $\dot{K}$, &c., may also be employed, as in the Berzelian notation and would in many cases be extremely convenient.

All the typical formulas now so generally employed will be written as at present, the actual weights only being changed. The general acceptance of the views of the new school would be greatly facilitated by the adoption of the system of atomic weights here proposed.

In another paper I propose to discuss the question of the basicity of the elements with other points of special theoretical interest.

New York, Jan. 12th, 1861.

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ART. XXIII.—*Abstract of a Meteorological Journal for the year* 1860, *kept at Marietta, Ohio:* lat. 39° 25′ N., and long. 4° 28′ W. of Washington City; by S. P. HILDRETH.—[Thirty-fourth annual report.]

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	Rain—inches.	Prevailing Winds.	BAROMETER.		
	Mean.	Maximum.	Minimum.					Maximum.	Minimum.	Range.
	°		°							
January, . . .	32·66	61	3	15	16	3·25	S.S.W., & N.	30·00	29·05	·95
February, . . .	35·00	71	2	16	13	1·25	S.S.W., & N.W.	29·75	28·55	1·20
March, . . .	44·13	71	16	18	13	1·08	S.S.E., & N.W.	29·55	29·00	·55
April, . . .	54·30	83	24	13	17	5·30	S.S.E., & N.	29·75	28·65	1·10
May, . . .	65·50	91	39	13	18	2·88	E.S.E., & N.	29·58	29·10	·43
June, . . .	68·03	94	44	15	15	2·01	S.S.E., & W.	29·70	28·83	·87
July, . . .	73·68	95	49	16	15	5·87	E.S.E., & S.W.	29·60	29·08	·52
August, . . .	72·23	95	48	18	13	4·14	E.S.E., & N.	29·58	29·20	·38
September, . .	62·10	88	38	15	15	3·26	S.E., & N.	29·70	29·15	·55
October, . . .	62·17	84	33	16	15	4·35	S.S.W. & N.	29·65	28·95	·70
November, . . .	40·29	79	10	15	15	4·01	S.W., W., & N.W.	29·60	28·85	·75
December, . .	30·13	51	11	7	24	2·08	W.N.W., & E.	29·85	28·73	1·12

The mean temperature of the year is 53°·35. The amount of rain and melted snow is 39·58 inches.

Remarks on the year 1860.—This year has been characterized by several uncommon events in the meteorology of the climate, such as wide-spreading and destructive storms, with tornadoes of unprecedented violence sweeping every thing in their course from the face of the earth with the impetuosity and force of gunpowder, raising the question whether its main power was not derived from electricity, rather than from the winds. Some portions of the valley of the Ohio and of the Mississippi suffered immensely from these storms in the months of May and June, which periods seem to be more liable to such outbreaks of the elements than any other portions of the year. Setting aside these events, the year has been one of uncommon fertility and productiveness. The crops of grain and fruit were abundant and never excelled in quantity since the first settlement of the country. The health of the adult portion of the population has been good, uncommonly exempt from fevers; in place of which has prevailed a new form of the old and well known scarlet fever, or 'putrid sore throat,' chiefly confined to children, but of a most fatal and destructive type. Like the cholera, it appears to be epidemic in its character, and after a certain period will run its course and disappear from the land.

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TEMPERATURE, AND REMARKS ON THE SEASONS.

Winter months.—The mean temperature of the winter is 32°·95, proving it to have been a very mild one, as it is sometimes as low as twenty-six degrees. The first week in January was the coldest of the winter, the temperature being below freezing all the time, and on the fifth at three degrees below zero. The Ohio river was closed for a few days above Marietta, but soon opened, leaving the navigation for steamboats free, the remainder of the winter. In ponds and the mouths of creeks, ice formed of the thickness of six or eight inches, and a plentiful supply was procured for summer use of this needful article of comfort. The greatest depth of snow, at any one time, was three inches, on the 21st of December.

Spring.—The mean of the spring months was 54°·64, which is about the average for a series of years. This season is called earlier or later from the blossoming of a certain class of trees, especially fruit trees, the peach and apple being the standard. The former did not bloom until the eighth of April, and the latter on the fifteenth of that month, which may be called about the mean time, although the period varies as much as twenty-five or thirty days in some years. It was a spring of mild, pleasant temperature, and favorable to the growth and health of the vegetable kingdom, but marked by several unusual phenomena in the meteorological department of nature. The early part of April was attended with excessive rains, producing floods in the Ohio and Muskingum rivers, overflowing the bottom lands to a great depth, and higher by four feet at Dresden and two feet at Zanesville, than ever before. The main source of the flood was in the rivers that fall into the Ohio, on the north side, as the Scioto, Muskingum, Beaver and Alleghany. The southern affluents were not very high, or the water would have equalled that of 1832. But little damage was done below Marietta, which, standing at the junction of the Muskingum with the Ohio, suffers more than any other point ten miles above or below that place. At this town the water was four feet below the flood of 1832, but twelve inches higher than any other one.

Great meteor of May, 1860.—On the first day of May, about twenty minutes before one o'clock, P. M., a tremendous explosion was heard at Marietta, like the discharge of a piece of heavy artillery, the sound coming from the north. It was found to proceed from the explosion of an aërolite or meteor, which fell at a place about fifty miles north of Marietta, and twenty east of Zanesville. Its course with a description of the accompanying phenomena has been given in this Journal by Profs. Andrews and Evans of the Marietta College, and Dr. J. L. Smith; the first and last named gentlemen having personally visited the locality

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where it fell, a few days subsequently, and minutely examined all the attending circumstances noted by the inhabitants in the vicinity. One of the largest fragments, weighing over one hundred pounds, was purchased and placed in the cabinet of Marietta College. Appearing, as this meteor did, in the middle of the day, when hundreds of spectators were in situations to see it, the history of its course and appearance has happily been made out more accurately and satisfactorily than that of any other which has visited North America.

Great storm of the 21st of May.—On Monday, the twenty-first day of May, the valley of the Ohio was visited by one of the greatest storms or tornadoes ever experienced since the settlement of the country. Commencing west of the Mississippi river, it swept over a space not less than six or seven hundred miles in length by fifty or sixty in breadth, following generally the course of the Ohio river, or from the southwest to the northeast. I do not know the hour of its commencement, but it was at Louisville, Ky., by two o'clock, P. M., at Cincinnati by half past three, at Portsmouth by half past four, and at Marietta about half past five, travelling at the rate of eighty or one hundred miles an hour, far exceeding in rapidity that of any railway train. Its progress was marked by desolation and ruin, in the destruction of buildings, fences, trees and boats. Of the latter, many coal boats were sunk and the navigators drowned. Several hundred lives were lost. Steamboats suffered less, as by their motive power they were able to gain a more sheltered position on the bends of the river. Louisville, Cincinnati and Portsmouth suffered more than any other towns, being larger and more fully exposed to the fury of the storm. Marietta suffered but little, the force of the tornado being expended before it reached that place. In its full force it was attended with thunder, lightning, hail and torrents of rain, pouring from the clouds more like a cataract than rain. The air was filled with leaves, fragments of branches and broken pieces of buildings, which, with the mist, produced a darkness equal to that of a cloudy night, requiring the aid of candles to go about the house. The violence of the storm at any one place did not last over half an hour. At Marietta the day was cloudy with a brisk breeze from the southwest in the forenoon, in the afternoon it veered to the south. At 5 P. M. heavy dark clouds appeared in the west, with a good deal of commotion and some thunder. At half past five it began to rain a little. A quarter before six, wind very violent from the southwest and west, with hard rain, blowing steadily and not in gusts as in ordinary storms, lasting about twenty minutes. As soon as the rain ceased, the sky or hazy clouds in the west and southwest put on a deep orange or copper color, and after seven until dark, a brilliant red, like the rays of light

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in the aurora borealis. The night following was calm and clear. The mercury in the barometer, in the forenoon, was 29·10, and kept rising during the violence of the tempest, being at 29·15 at 5 P. M., and at 29·23 at 9 o'clock. At Wheeling, Va., 80 miles southeast of Marietta, there was only an ordinary gale, its force being spent before reaching there. No similar tornado has visited the valley of the Ohio since Sunday, the 28th day of May, 1809. This struck Marietta about 4 o'clock P. M. with more violence than in 1860. There was little or no rain or thunder; several houses were unroofed and some blown down, with immense destruction of forest trees. It was greater in breadth and probably as extensive as that of this year. I was living in the town at that time and witnessed its ravages. Brown's Cincinnati Almanac for the year 1810 contains the only printed account of it that I have seen; but probably the newspapers of that period noticed it, as there were then nine or ten published in Ohio.

Summer.—The mean of the summer months was 71°·31, which is a full average for this season of the year. Heat and moisture were distributed by a beneficent Providence in due season and in quantities fully adequate to the wants of vegetation, producing one of the most abundant harvests in all the various varieties of cereal productions common to this climate. In some of the southern counties whole fields of wheat were destroyed by that pernicious insect, *Tinea granella*, after it had attained its full growth. This miller is a different insect from the Hessian fly; the ravages of the former are confined to the grain, where it deposits its eggs when in the milk, while the 'fly' makes its attacks on the culm, laying its eggs in the autumn and spring. This miller in some districts, especially in Washington county, was very injurious, its larvæ devouring the grain in whole fields, leaving none for the farmer. Happily its ravages were limited. A remedy is said to be found in a new variety of wheat, which the Tinea does not molest, and which is already coming into cultivation. The meadows furnished an abundance of grass, and the pastures were green until late in the autumn. In some fields the potatoes suffered from the disease called 'the rot,' but generally the crop was abundant and good.

Autumn.—The mean of the autumnal months was 54°·85, a temperature adequate to the wants of the season. Indian corn, the main crop of the valley of the Ohio, and of more importance to the farmer than that of any other grain, was very abundant in quantity and excellent in quality. It ripened early, and was ready to be cut up by the twentieth of September. This year, from the supply of rains at the right time, the crops on the hills and uplands were nearly as good as in the rich bottom lands of the rivers, while on the latter, the heavy deposits of vegetable mould left by the overflow in April added unusual fer-

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tility to the soil, producing crops of corn from eighty to one hundred bushels an acre, remunerating the husbandman for his extra labor in replowing and replanting his fields. Fruit of all kinds was abundant, especially apples and peaches. All the smaller fruits were in great perfection. Grapes matured without much loss from mildew or insects. Melons were never better or more plentiful. The forests abounded in acorns and nuts, bending their branches under their uncommon load. On every department of the vegetable kingdom the God of nature has bestowed his blessing in a manner rarely before witnessed.

Floral calendar.—February 24th, the Robin appears in flocks; 27th, Bluebirds.—March 1st, Blackbirds in flocks, yellow crocus in bloom; 7th, flocks of the cherry lark, White Crocus; 14th, Persian Iris; 16th, blue Crocus; 20th, Crown Imperial nearly open; 25th, Sugar maple; 26th, Golden bell or Forsythia viridis; 28th, Magnolia conspicua ready to open, but injured by the late frosts.—April 1st, Primrose in bloom; 3d, Hyacinth; 6th, Peach partly open in warm exposures; 7th, Sanguinaria canadensis; 8th, Peach in full bloom, Plum trees, Pears and Cherries; 11th, white Narcissus; 15th, Apple tree in bloom; 16th, Redbud or Circis canadensis, Hydrastis canadensis; 18th, Cornus Florida; 23d, Lilac; 26th, Tulips in bloom.—May 1st, Black Haw tree in bloom; 2d, Quince tree, Harebell; 5th, Native crab apple; 7th, Horse chestnut; 8th, Wigelia rosea; 11th, Harrison yellow rose and fragrant Syringa; 13th, Locust or Pseudoaensia; 14th, Prunus Virginiana; 25th, Syringa Philadelphia.—June 10th, White Lily; 17th, Catalpa tree; 30th, Juneating apple ripe.—July 5th, Amaryllis formosa; 7th, Blackberry ripe; 8th, American broom in bloom; 12th, Chestnut tree.—August 1st, Green gage plum ripe, and Summer Virgaleu pear; 8th, Watermelons ripe in open ground; 16th, Sweet potatoes in market.

Marietta, Ohio, January 1, 1861.

Art. XXIV.—*On the Theory of Types in Chemistry;* by T. Sterry Hunt, F.R.S.

In the *Annalen der Chimie und Pharmacie* for March, 1860 (cxiii, 293), Kolbe has given a paper on the natural relations between mineral and organic compounds, considered as a scientific basis for a new classification of the latter. He objects to the four types admitted by Gerhardt, (namely, hydrogen, hydrochloric acid, water and ammonia,) that they sustain to organic compounds only artificial and external relations, while he conceives that between these and certain other bodies there are natural relations having reference to the origin of the organic spe-

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cies. Starting from the fact that all the carbon compounds found in the vegetable kingdom are derived from carbonic acid with the concurrence of water, he proceeds to show how all the bodies of the carbon series may be deduced from an oxyd of carbon, which is either carbonic acid, carbonic oxyd, or the hypothetical C_2O.

When in the former (C_2O_4) we replace an atom of oxygen by one of hydrogen we have C_2O_3H, or anhydrous formic acid; the replacement of a second equivalent would yield $C_2O_2H_2$, or the unknown formic aldehyd; a third, C_2OH_3, the oxyd of methyl, and a fourth, C_2H_4, or formene. By substituting methyl, C_2H_3, for one or more atoms of hydrogen in the preceding formulas we obtain those of the corresponding bodies of the vinic series, and it will be readily seen that by introducing the higher alcoholic radicals we may derive from C_2O_4 the formulas of all the alcoholic series. A grave objection to this view is however found in the fact that while the anhydrid may in this way be made the type of the aldehyds, acetones and hydrocarbons, it becomes necessary to assume the hypothetical C_2O_4HO as the type of the acids and alcohols. Oxyd of carbon, C_2O_2, is according to Kolbe to be received as the type of hydrocarbons like olefiant gas, ($C_2H.C_2H_3$,) while C_2O, in which ethyl replaces oxygen is C_6H_5 or lipyle, the supposed triatomic base of glycerine.

The monobasic organic acids are thus derived from a single molecule of carbonic acid, while bibasic acids like the succinic are by Kolbe deduced from a double molecule, and tribasic acids like citric from a triple molecule, C_6O_{12}. He moreover compares sulphuric acid to carbonic acid and deduces from it by substitution the various sulphuric organic compounds. Ammonia, phosphuretted and arseniuretted hydrogen are regarded as so many types, and by an extension of his view of the replacement of oxygen by electro-positive groups the ethylids like ZnEt, $PbEt_2$, and $BiEt_3$, are by Kolbe assimilated to the oxyds, ZnO, PbO_2, and BiO_3.*

Ad. Wurtz, in the *Repertoire de Chimie Pure* for October, 1860, has given an analysis of Kolbe's memoir (to which, not having the original before me, I am indebted for the above sketch), and follows it by a judicious criticism. While Kolbe introduces as types a number of mineral species, including the oxyds of carbon, sulphur, and the metals, Wurtz would maintain but three, hydrogen (H_2), water (H_2O_2), and ammonia (NH_3), and these three types, as he endeavored to show in 1855, represent different degrees of condensation of matter. The molecule of hydrogen, H_2 or M_2, corresponding to four volumes, combines with

* See on this subject Dr. Frankland's late excellent lecture on Organo-metallic bodies in the Quarterly Journal of the Chemical Society, July, 1860, Nos. L, LI.

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two volumes of oxygen (O_2) to form four volumes of water, and may thus be regarded as condensed one-half in its union with oxygen, and derived from a double molecule, M_2M_2. In like manner four volumes of ammonia, NH_3, contain two volumes of nitrogen and six of hydrogen, which being reduced to one-third corresponds to a triple molecule, M_3M_3, so that these three types and their multiples are reducible to that of hydrogen more or less condensed.—(Wurtz, *Ann. de Chimie et de Physique*, [3], xliv, 302.)

As regards the rejection of water as a type of organic compounds and the substitution of carbonic acid, founded upon the consideration that these bodies in nature are derived from C_2O_4, Wurtz has well remarked that water, as the source of hydrogen, is equally essential to their formation, and farther that the carbonic anhydrid, like all other anhydrous acids, may be regarded as a simple derivative of the water type. Having then adopted the notion of referring a great variety of bodies to a mineral species of simple constitution, water is to be preferred to carbonic acid, 1st, because we can compare with it many mineral compounds which can with difficulty be compared with carbonic acid, and 2d, because the two atoms of hydrogen in water being replaceable singly, the mode of derivation of a great number of compounds (acids, alcohols, ethers, etc.) is much more simple and natural than from carbonic acid. As Wurtz remarks, Kolbe has so fully adopted the theory of types that he wishes to multiply them, and even admits condensed types, which are, however, molecules of carbonic acid and not of water; "he combats the types of Gerhardt and at the same time counterfeits them."

Thus far we are in accordance with Wurtz, who has shown himself one of the ablest and most intelligent expounders of the doctrine of molecular types as above defined, now almost universally admitted by chemists. He writes, "to my mind the idea of referring to water, taken as a type, a very great number of compounds is one of the most beautiful conceptions of modern chemistry;" and again he declares the idea of regarding water and ammonia as representatives of the hydrogen type more or less condensed, to be so simple and so general in its application that it is worthy "to form the basis of a system of chemistry." (*Repertoire de Chimie Pure*, 1860, pp. 356–359.)

We have here two important conceptions; the first is that of hydrogen and water regarded as types to which both mineral and organic species may be referred, and the second is the notion of condensed and derived types, according to which we not only assume two or three molecules of hydrogen, water or ammonia as typical forms, but even look upon water as the derivative of hydrogen, which is itself the primal type.

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As to the history of these ideas, Wurtz remarks that the proposition enunciated by Kolbe that "all organic bodies are derived from mineral compounds, from which they take their origin, in part directly, by processes of substitution of great simplicity," is not new, but "known in the science for about ten years. Williamson was the first who said 'alcohol, ether and acetic acid are compounds comparable to water, organic waters.' Hofmann and myself had already compared the compound ammonias to ammonia itself. * * * To Gerhardt belongs the merit of generalizing these ideas, of developing them, and supporting them with his beautiful discovery of anhydrous organic monobasic acids. Although he did not introduce into the science the idea of types, which belongs to Dumas, he gave it a new form, which is expressed and essentially reproduced by the proposition of Kolbe." "Gerhardt reduced all organic bodies to four types, hydrogen, hydrochloric acid, water and ammonia." (*Repertoire, etc.*, p. 355.)

The historical inaccuracies of the passage just quoted are the more surprising, since in March, 1854, I published in this Journal ([2], xvii, 194,) a concise account of the progress of these views. This paper was republished in the *Chemical Gazette* (1854, p. 181), and copies of it were by myself placed in the hands of most of the prominent chemists of England, France and Germany. In this paper I have shown that the germ of this idea of mineral types is to be found in an essay by Auguste Laurent, (*Sur les combinaisons azotées, Ann. de Chimie et de Physique*, Nov. 1846,) where he showed that alcohol may be looked upon as water H_2O_2 in which ethyl (C_4H_5) replaces one atom of hydrogen, while hydric ether is the result of a complete substitution of the hydrogen by a second atom of ethyl. Hence he observed that while ether is neutral, alcohol is monobasic and the type of the monobasic vinic acids, as water is the type of bibasic acids. In extending and developing this idea of Laurent's I insisted in March, 1848, and again in January, 1850, upon the relations between the alcohols and water as one of homology, water being the first term in the series, and H_2 in like manner the homologue of formene and acetene, while the bases of Wurtz were said to sustain to their corresponding alcohols the same relation that ammonia does to water. (This Journal, v, 265, ix, 65.)

In a notice of his essay published in September, 1848, (Ibid, vi, 173,) I endeavored to show that Laurent's view might be farther extended so as to include in the type of water, "all those saline combinations (acids) which contain oxygen," and in a paper read before the American Association for the Advancement of Science, at Philadelphia in Sept. 1848, I farther suggested that as many neutral oxygenized compounds which do

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not possess a saline character are derivatives of acids which are referrable to the type H_2O_2, "we may regard all oxygenated bodies as belonging to the type H_2O_2," which as I farther showed in the same essay is but a derivative of the primal type H_2, to which I referred all hydrocarbons and their chlorinized derivatives, as also the volatile alkaloids, which were regarded "as amidized species" of the hydrocarbons, in which the residue amidogen, NH_2, replaced an atom of H or Cl, or what is equivalent, the residue NH took the place of O_2 in the corresponding alcohols. (Ibid., viii, 92.)

In the paper published in Sept. 1848, I showed that while water is bibasic, the acids which like hypochlorous and nitric acids are derived from it by a substitution of Cl and NO_4 for H, are necessarily monobasic, and I then pointed out the possible existence of the nitric anhydrid $(NO_4)_2O_2$, the result of a complete substitution, which was soon after discovered by Deville. Gerhardt at this time denied the existence of anhydrids of monobasic acids; he regarded anhydrids as characteristic of polybasic acids, and indeed was only lead to adopt my views by the discovery of the very anhydrids whose formation I had foreseen.*

In explaining the origin of bibasic acids I described them as produced by the replacement in a second equivalent of water of an atom of hydrogen by a monobasic saline group; thus sulphuric acid would be $(S_2H_6O_6H)O_2$. Tribasic acids in like manner were regarded as derived from a third equivalent of water in which a bibasic residue replaces an atom of hydrogen. The idea of polymeric types was still farther illustrated in the same paper where three hydrogen types were proposed, (HH), (H_2H_2) and (H_3H_3), corresponding to the chlorids MCl, MCl_2, and MCl_5. (This Journal, vi, 174.)

I also showed that hydrogen is to be looked upon as the fundamental type, from which the water type is derived by the replacement of an atom of hydrogen by the residue HO_2; thus $(HO_2.H)$, (Ibid, viii, 93). In the same way I regarded ammonia as water in which the residue NH replaced O_2.

I farther pointed out that sulphur in its ordinary state was to be regarded as a triple molecule, S_3 (or S_6=4 volumes), and referred sulphurous acid, SO_2 (S_2O_4), to this type to which also belongs selenic oxyd. At the same time I suggested that the odorant form of oxygen, ozone might be O_3. Wurtz has since adopted sulphur vapor at 400° C. or S_6 as the type of the triple

* The anhydrids of the monobasic acids correspond to two equivalents of the acid minus one equivalent of water, as $2(NHO_6)-H_2O_2=N_2O_{10}$, while those of the bibasic acids are formed from one equivalent of the acid by a similar elimination of an equivalent of water, thus $C_2H_2O_6-H_2O_2=C_2O_4$. Hence both classes of anhydrids are to be referred to the type of one molecule of water, H_2O_2.

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molecule.—(*Ann. de Chim. et de Phys.*, xliv, 310.) In the same paper I suggested that gaseous nitrogen was to be regarded as an anhydrid amid, or nitryl, which may be derived from nitrite of ammonia as nitrous oxyd is from the nitrate, thus (NO_3. NH_4O)$-4HO=NN$.*—(This Journal, v, 408, vi, 172.) A late writer attributes this view to Gerhardt, who adopted it from me.

I have always protested against the view which regards the so-called rational formulas as expressing in any way the real structure of the bodies thus represented. These formulas are invented to explain a certain class of reactions, and we may construct from other points of view other rational formulas which are equally admissible.

As I have elsewhere said "the various hypotheses of copulates and radicals are based on the notion of dualism, which has no other foundation than the observed order of generation, and can have no place in the theory of the science." All chemical changes are reducible to union (identification,) and division (differentiation). When in these changes only one species is concerned, we designate the process as metamorphosis, which may be by condensation or by expansion (homogeneous differentiation). In metagenesis on the contrary unlike species may unite, and by a subsequent heterogeneous differentiation give rise to new species, constituting what is called double decomposition, the results of which, differently interpreted, have given origin to the hypothesis of radicals and the notion of substitution by residues to express the relations between the parent species and their progeny. The chemical history of bodies is a record of their changes; it is in fact their genealogy, and in making use of typical formulas to indicate the derivation of chemical species we should endeavor to show their ordinary modes of generation. (See *On the theory of chemical changes*, this Journal, xv, 226; *L. E. & D. Phil. Mag.*, [4], v, 526, and *Chem. Centralblatt*, 1853, p. 849, also *Thoughts on solution*, this Journal, xix, 100, and *Chem. Gazette*, 1855, p. 92.)

Keeping this principle in mind, let us now examine the theory of the formation of acids. As we have just seen, I taught in 1848 that the monobasic, bibasic and tribasic acids are derived respectively from one, two and three molecules of water, H_2O_2. Mr. Wurtz in 1855 put forth a similar view. He supposes a monatomic radical PO_4', a diatomic radical PO_3'', and a triatomic radical PO_2''' replacing respectively one, two and three atoms of hydrogen in H_2O_2, H_4O_4, and H_6O_6; thus $(PO_4'H)O_2$ $(PO_3''H_2)O_4$, and $(PO_2'''H_3)O_6$. These radicals evidently correspond to PO_5 which has lost one, two and three atoms of ox-

* May not nitrogen, as we have elsewhere suggested, under certain conditions regenerate ammonia and a nitrite, and may not this reaction enter into certain processes of nitrification? I propose at an early day to consider this question.

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ygen in reacting upon the hydrogen of the water type, and the acids may be accordingly represented as found by the substitution of the residue PO_2-O, for H, etc.

To this manner of representing the generation of polybasic acids we object that it encumbers the science with numerous hypothetical radicals,* and moreover fails to show the actual successive generation of the series of acids in question. When phosphoric anhydrid $P_2O_{10}=(PO_4)_2O_2$ is placed in contact with water it combines with one equivalent, H_2O_2. The union is followed by homogeneous differentiation, and two equivalents of metaphosphoric acid result; $(PO_4)_2O_2+H_2O_2=2(PO_4H)O_2$. Two equivalents of this acid in contact with one of water at common temperatures are slowly transformed into two of pyrophosphoric acid, by a reaction precisely similar to the last; $2(PHO_6)=(PHO_5)_2O_2+H_2O_2=2(PHO_5.H)O_2$; and two equivalents of pyrophosphoric acid when heated with a third equivalent of water yield in like manner two of tribasic phosphoric acid; $2(PH_2O_7)=(PH_2O_6)_2O_2+H_2O_2=2(PH_2O_6.H)O_2=2PH_3O_8$.

The above, which we conceive to be a simple statement of the process as it takes place in nature, dispenses alike with hypothetical radicals and residues, both of which are however convenient for the purposes of notation. In the selection of a typical form to which a great number of compounds may be referred, hydrogen or water, from its simplicity, as already remarked by Wurtz, and also from the important part which it plays in the generation of species, merits the preference. Water and carbonic acid are both so directly concerned in the generation of the bodies of the carbon series, that either may be assumed as the type, but we prefer to regard C_2O_4 like all the other anhydrids as a derivative of water and eventually of the hydrogen type.

These views were first put forward by myself in 1848, when I expressed the opinion that they were "destined to form the basis of a true natural system of chemical classification," and it was only after having for four years opposed them to those of Gerhardt, that this chemist in June, 1852, renounced his former views, and without any acknowledgment, adopted my own (*Ann. de Chimie et de Physique* [3], xxxvii, 285). Already in 1851, Williamson in a paper read before the British Association developed the ideas relative to the water type to which Wurtz refers above, and to Williamson the English editor of Gmelin's

* Those who are familiar with chemical literature will remember an amusing *jeu d'esprit* of the lamented Laurent in which he invited the attention of the advocates of the radical theory to a new electro-negative radical which he named Eurhizene, (*Comptes Rendus des Travaux de Chemie*, 1850, pp. 251 and 376). It was not without a smile that we observed a late writer in *The Chemical News*, vol. i, 326, proposing as a newly invented radical under the name of hydrine, the peroxyd of hydrogen HO_2, the eurhizene of Laurent!

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Handbook, ascribes the theory. The notion of condensed types, and of hydrogen as the primal type, was not so far as I am aware brought forward by either of these, and remained unnoticed until resuscitated by Wurtz in 1855, seven years after I had first announced it, and one year after my reclamation published in this Journal in March, 1854.

My claims have not however been overlooked by Dr. Wolcott Gibbs; in an essay on the polyacid bases, he remarks that in a previous paper he had attributed the theory of water types to Williamson and Gerhardt, and adds "in this I find I have not done justice to Mr. T. Sterry Hunt, to whom is exclusively due the credit of having first applied the theory to the so-called oxygen acids and to the anhydrids, and in whose earlier papers may be found the germs of most of the ideas on classification usually attributed to Gerhardt and his school." (Proc. Amer. Assoc. for the Advancement of Science, Baltimore, May, 1858, p. 197.)

It will be seen from what precedes that I not only applied the theory, as Dr. Gibbs says, but except so far as Laurent's suggestion goes, invented it and published it in all its details some years before it was accepted by a single chemist.

In conclusion I have only to ask that future historians will do justice to the memory of Auguste Laurent, and will ascribe to whom it is due the merit of having given to the science a theory which has exercised such an important influence on modern chemical speculation and research, remembering that my own publications on the subject, which cover the whole ground, were some years earlier than those of Williamson, Gerhardt, Wurtz or Kolbe.

Montreal, Canada, Jan. 5, 1861.

Note to Mr. Hunt's paper on Types.—Gerhardt long since maintained that we can not distinguish between polybasic salts and what are called subsalts, which are as truly neutral salts of a particular type. Thus the bibasic and tribasic phosphates are to be looked upon as subsalts which sustain the same relation to the monobasic phosphates that the basic nitrates bear to the neutral nitrates. He succeeded in preparing two crystalline subnitrates of lead and copper, having the formulas $NO_5.M_2O_2.HO$ (tribasic), and $NO_5.M_4O_4.H_3O_3$ (quadri or septabasic), both of which retain their water of composition at 392° F. The compounds of sulphuric acid are, 1st, the true monobasic sulphate, $S_2O_6.MO$, corresponding to the Nordhausen acid and to the anhydrous bisulphates. 2d, the ordinary neutral sulphate, $S_2O_6.M_2O_2$. 3d, the so-called disulphates, $S_2O_6.M_4O_4$, corresponding to the crystallized or glacial acid, density 1·780; 4th, the sulphates, $S_2O_6.M_6O_6$, represented by turpeth mineral; and, 5th, the so-called quadribasic sulphate, $S_2O_6.M_8O_8$. The copper salt of this type, according to Gerhardt, retains moreover 6HO at 392° F. Without counting the still more basic sulphates of zinc and

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copper described by Kane and Schindler, we have a monobasic sulphate, *a*, S_2HO_7; a bibasic, *b*, $S_2H_2O_8$; a quadribasic, *c*, $S_2H_4O_{10}$; a sexbasic, *d*, $S_2H_6O_{12}$; and an octobasic, *e*, $S_2H_8O_{14}$. (*Gerhardt on Salts, Jour. de Pharmacie*, 1848, vol. xii, and this Jour., vi, 336.) These salts, in accordance with Wurtz's notation, correspond to the following radicals: *a*, S_2O_5, monatomic; *b*, S_2O_4, diatomic; *c*, S_2O_2, quadri-tetratomic; *d*, S_2, hexatomic; and *e*, S_2-O_{10}, octo-atomic. It is easy to apply a similar *reductio ad absurdum* to the radical theory in the case of the oxychlorids and other basic salts and to show that the radicals of the dualists are often merely algebraical expressions. (See farther my remarks, this Journal, vii, pp. 102–104.)

ART. XXV.—*Description of three new Meteorites.—Lincoln County Meteoric stone which fell in August*, 1855—*Oldham County* (*Ky.*) *Meteoric Iron—Robertson County* (*Tenn.*) *Meteoric Iron;* by J. LAWRENCE SMITH, M.D., Prof. Chem. Med. University of Louisville.

LINCOLN COUNTY METEORITE.—This meteorite was examined several years ago having been sent to me for that purpose by Prof. J. M. Safford, State Geologist of Tennessee; the result of my examination was embodied in Prof. Safford's report of the geology of Tennessee for 1855, but has never received a special notice in any scientific journal, and as it is not too late to make up that deficiency, the following is sent for publication, embracing Prof. Safford's account of its fall with the chemical examination. The following particulars in regard to its fall were furnished by the Rev. T. C. Blake of Cumberland University.

"It fell two miles west of Petersburg, and fifteen northwest of Fayetteville, in Lincoln county, about half-past three o'clock, P. M., August 5th, 1855, during, or just before, a severe rainstorm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five lesser reports; these were heard by many persons in the surrounding country. Immediately after, this mass or fragment was seen by James B. Dooley, Esq., to fall to the ground. It approached him from the east, appeared, while falling, to be surrounded by a "milky" halo, two feet in diameter, and fell one hundred and fifty or two hundred yards from him, burying itself about eighteen inches in the soil. When first dug out, it was too hot to be handled.

This specimen has an edge broken off, revealing the character of the interior. Within it is of an ashen-gray color, varied by patches of white, yellowish and dark minerals.

With the exception of the broken edge, it is covered, and when first obtained was entirely covered, as most meteorites of

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this kind are, with a very 'black, shining crust, as if it had been coated with pitch.'

One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging $2\frac{3}{4}$ by $2\frac{1}{2}$ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form approaching roughly an oblique pyramid. The length from the base to the apex is $4\frac{1}{2}$ inches.

Three adjacent sides are rough, being covered with cavities and pits. The other sides are smoother and rounded.

The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3·20. Its weight, in its present condition, 3 lbs., $14\frac{1}{4}$ oz.

The minerals found in the meteorite are:

Pyroxene—principal portion of the mass;

Olivine and orthoclase—disseminated through the mass;

Nickeliferous iron—forming about one half per cent of the mass.

In addition to these, there are specks of a black, shining mineral, not yet examined."

The general analysis is as follows:

Silica	49·21
Alumina	11·05
Protoxyd of iron	20·41
Lime	9·01
Magnesia	8·13
Manganese	.04
Iron	·50
Nickel	minute quantity.
Phosphorus	" "
Sulphur	·06
Soda	·82
	99·23

The minute quantity of nickel that was separated did not permit of my examining for cobalt, but there is no doubt that this metal was present.

OLDHAM COUNTY METEORITE.—The announcement of the discovery of this iron meteorite with the one that follows was made in a note in the last number of this Journal.

It was discovered in the month of October 1860, by Mr. Wm. Daring near Lagrange, in Oldham County, Ky. There is nothing known with reference to the time of its fall. It came into my possession shortly after its discovery.

It was entire and weighed *one hundred and twelve pounds.* Its extreme dimensions were, length twenty, breadth ten and three-

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fourths, and thickness six and a half inches; its shape was elongated and flattened. Its specific weight is 7·89 and an analysis furnished

Iron	91·21
Nickel	7·81
Cobalt	·25
Copper	minute quantity not estimated.
Phosphorus	·05
	99·32

ROBERTSON COUNTY METEORITE.—This mass of meteoric iron came into my possession during the month of December, 1860, being sent by Prof. Lindsley of Nashville, Tenn. It was discovered by Mr. D. Crockett, near Coopertown, in Robertson county, Tenn. The time of its fall is not known.

Its weight was *thirty-seven pounds*, its form was wedge-shaped, and its extreme dimensions, length ten, breadth nine and a half, thickness five and a half inches. Its specific gravity is 7·85. On cutting through the mass, a module of sulphuret of iron was discovered about $\frac{1}{4}$th inch in diameter, and there are doubtless others in its interior. The iron on analysis furnished

Iron	89·59
Nickel	9 12
Cobalt	·35
Copper	minute quantity not estimated.
Phosphorus	·04
	99·10

Louisville, January 29, 1861.

ART. XXVI.—*Correspondence of Mr. Jerome Nicklès, dated Nancy, December 5th*, 1860.

Obituary.—Since my last communication, France has lost three savans, one of whom was one of the oldest members of the Institute, and another one of the youngest. Of these two, the first is M. Duméril the zoologist, the second the botanist, Payer. The third is the hydrographer, M. Daussy, who many years since became unknown to science, and who is therefore least known of the three. He died the same day as M. Payer, viz., the 5th of September.

Duméril.—DUMÉRIL, who died the 14th of Aug., 1860, aged 87 years, was born at Amiens, Jan. 1st, 1774. He had a taste for natural history and a peculiar ability for teaching it, which he exercised without cessation whether at the School of Science at Paris, where he taught zoology, or at the School of Medicine, where he was Professor of anatomy, or at the Museum where he taught herpetology, a speciality which he pursued with great success. His first publications, having for their object the natural classification of insects, bear the date of 1797. In 1800, he compiled, under the direction of Cuvier, the first two volumes of *Leçons Anatomie Comparée* of that great naturalist, who was pleased to acknowledge that he had not only aided him by his pen, but that he was in-

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debted to him for many curious observations, among which was the analogy of structure existing between the vertebræ and the bones of the cranium. He may be considered as one of the founders of those anatomical theories which four years later exercised a powerful influence upon the direction of the studies of naturalists.

About the same time Duméril succeeded Cuvier as professor at the central school of the Pantheon, where he had for his colleague, Alexander Brongniart. In 1802, Lacépide entrusted to him, the course on herpetology and ichthyology at the Museum. He filled this appointment for 55 years; during this period he formed, at the Museum, the most beautiful collection of herpetology which exists, as well as a menagerie for reptiles, the first which had been undertaken. About this time he also published in connection with M. Bibron his valuable work on general herpetology.

Afterwards he was engaged upon his *Icthyologie Analytique;* he was then 80 years of age: still later he wrote his *Entomologie Analytique*, in two volumes. When he presented this work to the Academy of Sciences he was 87 years of age.

Like Duvernoy, his rival and fellow disciple,* he devoted as much as half of his time to the practice of medicine and in 1805 he is seen in Spain confronting the dangers of a malignant epidemic in order to contribute to the progress of his art: thus he never overlooked the practice of medicine, although as has been stated, he taught comparative anatomy. He occupied successively several different chairs in the faculty of Medicine at Paris.

M. Payer.—Jean Baptiste Payer, died September 5th, 1860. Born February 3d, 1818, at Asfeld, (in the Department of Ardennes,) he was at an early age distinguished for the splendor of his oratory. He entered upon the study of law and the sciences and was made doctor in 1840. In the same year he was appointed Professor of mineralogy and geology at the Faculty of Science of Rennes. He did not long retain this position which diverted him from his favorite pursuit of botany. He returned to Paris the following year to teach Botany at the Normal School, and to supply the place of M. de Mirbel at the Faculty of Sciences.

Although constantly occupied as incumbent of the chair of botany he fitted himself to receive the degree of Doctor of Medicine and Pharmacy in 1843, at the school of Pharmacy at Strasbourg. There are two other schools of Pharmacy in France, viz., at Paris and Montpellier, but that at Strasbourg is the most important in relation to the studies which are pursued there, and the care with which the students are exercised in the pursuits of chemistry and natural history. Payer passed there, the following year, his fourth examination, as did the chemist, Gerhardt, the next subsequent year, and sustained with great honor a thesis upon the natural system of botany.

In 1848, after the revolution of February, he was appointed Minister of Foreign Affairs, by M. de Lamartine, chief of the cabinet, and he was also a representative of the people in the Constituent Assembly, where he belonged to the democratic party. Despite these distractions, he did not lose sight of his plans for the future, for they were realized in 1852,

* See this Journal, [2,] vol. xx, p. 105.

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when he was named for the chair of vegetable organography at the Faculty of Sciences of Paris, in place of Auguste de Saint-Hilaire.

This chair was soon united with that of Vegetable Anatomy and Physiology, which became vacant by the death of Adrian de Jussieu. It was about this time that Payer published his principal works on Natural History.

We are indebted to him for memoirs upon various questions in vegetable anatomy and physiology, but his most important labors were related to a new science called by M. de Mirbel, *Organogeny*. He developed the latter in a great work, entitled "*Traite d' Organogenie Végétale Comparée.*" He also published "*Botanique Cryptogamique ou Histoire des Familles Inférieures.*" He edited D'Adanson's "*Le Cours Elémentaire d'Histoire Naturelle,*" to which is added an introduction and notes on the natural families of plants by the same author. His treatise on organogeny made him the leader of a new school in which relation he is reproached for want of respect for his seniors: we have had occasion before to speak of this subject in this Journal, in 1857.

The death of Payer surprised every one, his friends not excepted, for they were unacquainted with his disease; he succumbed to the results of a surgical operation for a fistula; we shall presently allude to this again.

Pierre Daussy.—M. Daussy also succumbed to a surgical operation, which is usually devoid of danger, viz., lithotrity. Born at Paris in 1792, Pierre Daussy was admitted in 1806 to the corps of hydrographic engineers. After having, for fifteen years, taken part in the survey of the coast of France, he was nominated in 1829 as chief engineer of the French marine.

His memoir upon the perturbation of planets was in 1813, honored by the Academie des Sciences. Besides various articles furnished to the *Connaissance des Temps*, we are also indebted to him for a report upon the arc of the meridian between Dunkirk and the island of Formentara,* also for *Des Tables des Positions des Principaux Lieux du Globe*, 1847, *in* 4°, and a great number of other papers of much value.

Insalubrity of the air of Paris.—The operation, by no means severe, which cost M. Payer his life, has called attention to questions relating to the air of great cities. Dr. Castelnau reported in the *Moniteur des Sciences Médicales et Pharmaceutiques* that it had long been known to the surgeons of Paris, that surgical wounds do not unite as well in Paris as in the country. This may explain the numerous failures of Velpeau, chief surgeon of the Hospital La Charité. M. Castelnau declares that there is less danger to be apprehended from the operation of an empiric, than from an operation at Paris by the best surgeon. "Since this fact," says Dr. C., "is daily verified before our eyes, it is truly surprising that such an operation as M. Payer underwent, and which requires no haste, should be performed in the heart of Paris, when it is so easy to remove the patient to a healthy locality." Surgical operations performed at Paris, are frequently followed by erysipelas of a character more or less alarming, which appears to pass from one patient to another, as though carried by the clothes of the surgeon. Despite the ability of the operator, the Cæsarian section has never been successful at Paris. Amputations of the

* *Rapport sur la determination de la longueur de l'arc du méridien entre les parallèles de Dunkerque et I. Formentara.*

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thigh are almost always fatal at Paris, though they generally terminate favorably, when performed upon the field of battle.

Diffusion of Germs, (Panspermia), *Researches upon Spontaneous Generation.*—We recently gave our readers the views of this question entertained by Pouchet;* many scientific men have pronounced against the conclusions of this zoologist, and have referred the origin of the vegetable mycoderms obtained by him, where the atmospheric air was excluded, to microscopic germs floating in the air, and which are so small that they may be introduced into the apparatus, despite the precautions taken to exclude them. According to this theory it is necessary to suppose that the air is full of these germs, therefore Pouchet has undertaken to submit the atmospheric air to microscopic examination. He has not found either germs or spores of infusoria in the dust suspended in the air, but he has found a great number of grains of starch. The air of great cities and other inhabited places, contains many of these starch grains, which, according to him, one might take to be eggs of infusoria, or germs of mycoderms. He has found them among the dust of old cathedrals, and even in dust obtained from Egyptian mummies, and the chambers of the pyramids, as well as among the ruins of Grecian temples. Yet there must be something in the air which has escaped recognition by the microscope, for by causing a quantity of air to pass through a tube containing calcined asbestos, and introducing some of this material into liquids which previously had access only to calcined air, and which consequently contained no trace of vegetation, Pasteur has been able to develop mucedines. We have seen the apparatus of this chemist in use at the *École Normale de Paris*. This apparatus is remarkable for its simplicity and its precision, and it is impossible to object to his conclusions, for they preclude the possibility on the part of nature to continue her creative work in connection with elements purely mineral, or to animate them with the organic influence.

This chemist has already informed us,† that, in order that vegetation may be developed, or fermentation produced, there is required a liquid containing water, a salt having ammonia as a base, a carbonaceous substance, and a phosphate; the air is necessary only for the moment while we introduce into the flask, some spores of *penicilium*, or a little dust obtained from the air by the process indicated above. The mycodermic vegetation is then developed in less than a day, and, what is particularly remarkable, it is developed in the dark as well as in the light. The ordinary law does not govern these little organisms, for they neither give out oxygen nor absorb free carbonic acid; but on the contrary they disengage carbonic acid, and increase by fixing ammonia and phosphoric acid. The germs which produce these marvelous effects are not uniformly distributed in the air; thus Pasteur, making comparative experiments with one and the same liquid arranged in flasks completely deprived of air, found that the air from the cellars of the Observatory, contained only one-tenth part as many germs as the air from the court of that establishment; and

* See this Journal, [2,] xxvii, p. 253, and xxix, p. 414.
† See this Journal, [2,] xxix, p. 412.

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that the air contained fewer germs in proportion to its elevation in the atmosphere. This chemist has performed comparative experiments in the mountains of Jura, at an altitude of 800 metres, and in the Alps at Montanvert, (Savoy), at 2000 metres above the level of the sea; and he has proposed to take the air from a much greater elevation by the aid of a balloon.

These researches present an interesting field to the naturalist. Pasteur has many species in vegetation, new and hitherto unknown. By varying the conditions, it will doubtless be possible to obtain others, as Paul Laurent has already done with the infusoria in a work of which we shall speak further on. On the occurrence of these researches, Boussingault called attention to a fact pointed out by Bineau, of Lyons, who, while examining a specimen of rainwater, containing nitrates and ammonia in solution, found these materials disappearing under the influence of cryptogamic vegetation. In reference to this great question of the assimilation of nitrogen, we would refer the reader, who wishes to understand it thoroughly, to the valuable work of Boussingault, just published, entitled, "*Agronomie, Chimie Agricole et Physiologie.*"

In order that plants may be developed in meteoric waters, these waters should be found in the condition of Pasteur's liquids. It is known that rainwater contains assimilable nitrogen and also salts of potash, soda, lime, &c., but it has heretofore lacked the indispensable element, phosphoric acid, which had never been detected in rainwater. This chasm in the series of fertilizing principles of meteoric waters, has at length been filled by Barral, who has discovered phosphates in rainwater. To avoid all sources of error, this chemist has experimented entirely with an apparatus of platinum. In the residue of evaporation he has obtained the phosphorus in the condition of phosphoric acid, as phosphate of bismuth, (Chancel's process), and as the ammoniaco-magnesian phosphate. He has thus found a quantity of phosphoric acid, varying from ·05 to ·09 of a milligram to a litre of rainwater (=0·000·5 to 0·000·9 gram).

From these results it may be calculated that the rainwater of an ordinary shower furnishes about 400 grams of phosphoric acid to the French *hectare* (or 2½ English acres). Now since the researches of Boussingault have proved that a hectolitre, (2¾ bushels), of wheat takes from the soil about one kilogram of phosphoric acid, we see that to obtain seven or eight hectolitres of wheat to the French *hectare*, which corresponds to a harvest without the use of manure, it would be necessary to let the field repose for twenty years, if the soil did not previously contain a trace of phosphates. Barral in 1850 to 1852, made researches upon rainwater to detect the presence of phosphoric acid in the residue of evaporation; the udometres and other vessels of platinum employed in the present investigations were constructed at the expense of the Academie des Sciences.

Chemical Synthesis.—The most remarkable scientific event of modern times, is the publication of a treatise on chemistry, proceeding on the same plan in organic chemistry, as has been adopted for a century past, in mineral chemistry, that is, forming organic substances *synthetically* by combining their elements by the aid of chemical forces only. The author who has performed his demonstrations by this method, is Berthelot, who has been occupied with organic synthesis since he first devoted himself to

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chemistry. Berthelot is not a *vitalist*, (see our last contribution);* he is convinced that, "we may undertake to form *de novo*, all the substances which have been developed from the origin of things, and to form them under the same conditions, by virtue of the same laws and by means of the same forces which nature employs for their formation." Let us hasten to add a distinction upon which Berthelot properly insists and which it is necessary to recognize, between organs and the matter of which they are composed. "No chemist pretends to form in his laboratory, a leaf, a flower, a fruit or a muscle, these questions relate to physiology," and it was by not observing this distinction that it was possible to form that school of medicine of which mention was made in my last communication—and which referred everything to vital force. (See *Journal de Chimie et de Pharmacie*, Sept., 1860). This distinction being admitted and calling to mind the syntheses recently effected, such as the direct preparation of C^4H^4 from carbon and hydrogen, and alcohol from the union of C^4H^4 and water, we may understand the possibility of performing for organic chemistry what has been done for mineral chemistry, and to give to it a basis independent of the phenomena of life.

"I have taken for a point of departure, the simple bodies; carbon, hydrogen, oxygen and nitrogen, and I have constructed by combination of these elements, organic compounds, first binary then ternary, &c., the former analogous and the latter identical with the proximate principles contained in living beings themselves." Notice the progressive order of these synthetic formations. "The substances which we first prepare by methods purely chemical are the principal carbids of hydrogen, that is to say the fundamental binary compounds of organic chemistry. As a means of producing all the parts from the elements themselves, we take oxyd of carbon, that is to say a substance purely mineral, and by the concurrent influence of time and ordinary affinity, we combine this oxyd of carbon with the elements of water, (e. g., by the aid of pressure and the presence of an alkali); we thus obtain a first organic compound, known as formic acid. This acid united to a mineral base, produces a formate, then decomposing this formate by heat we compel the carbon of the oxyd of carbon and the hydrogen of the water to combine in the nascent state and produce carbid of hydrogen. Thus there is formed marsh gas, propylene, &c., &c. This is the first step of synthesis.

The hydrocarbons thus prepared become the starting point for the synthesis of alcohols; with marsh gas and oxygen we form methylic alcohol, with olefiant gas and water—ordinary alcohol, &c.

The synthetic production of carbids of hydrogen and of alcohols constitutes the true difficulty, but we know that even in this, Berthelot has triumphed.† The alcohols once obtained, it is easy to obtain the greater part of the other organic compounds by the ordinary chemical forces. This chemist has thus established the fact that organic chemistry reposes upon the same basis as mineral chemistry.

What has been said of the alcohols may also be said of various other classes of organic compounds, and among others of that new group, which Berthelot calls the *Phenols*, and to which he has devoted a very interest-

* This Journal, [2,] xxx, p. 412.

† See this Journal, [2,] xx, p. 111 and p. 265.

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ing chapter. *Phenol*, or *carbolic acid*, $C^{12}H^6O^2$, the type of this group, may also be obtained by direct synthesis.

Starting from benzine, $C^{12}H^6$, it is transformed by nitric acid into $C^{12}H^5NO^4$ (nitro-benzine), which under the influence of nascent hydrogen, (the Zinin process) becomes $C^{12}H^7N$, (aniline), and this under the influence of nitrous acid is changed into phenol, $C^{12}H^6O^2$, as was shown by T. S. Hunt, in this Journal, [2,] viii, p. 372.

In Synthesis, or the forces of nature, substituted for hypothesis, we see the basis of the truly original work, now under notice. Berthelot is the youngest, but also the most distinguished of our chemists.* He owes his success to the cause which gave power to Laurent, Gerhardt and other savans of the first order, to the guiding power of a fundamental idea, which in the case of Gerhardt, was, *Series*, but in the case of Berthelot, is *Synthesis*. He is only 34 years of age, and yet his work, "*La Chemie Organique, fondée sur la Synthese*" gives promise to its author of a glorious future, and to science great progress and brilliant discoveries.

Acclimation.—We have before mentioned a project conceived by the Society for Zoölogical Acclimation, (*Societé Zoölogique d'Acclimatation*)† of forming a model garden for conducting the acclimation of useful plants or animals, and for cultivating an interest in this kind of enterprise. This garden was opened the 6th of October last, and immediately made available to the public; considerable sums of money have been subscribed to make it both a useful establishment and a work of art. Fifteen months have been sufficient for this purpose. The Garden is established in the forest of Boulogne; besides the necessary buildings for offices, it includes large stables, many and elegant rustic pavillions, designed for different species of animals, an immense aviary, a large enclosure for fowls, an elegant nursery for silkworms, an aquarium of unusual extent, greenhouses, and a winter garden not yet entirely completed. The other buildings are completed and already filled. A large stream, drawn from the Seine flows through the garden and forms a beautiful ornament; it is occupied by a great number of aquatic birds.

The collection of the Zoological Garden of Acclimation, (*Jardin Zoologique d'Acclimatation*), is composed of, 1st, species and races which they have tried to acclimate in France; 2nd, species and races which have been acclimated in other countries, or which are habitually reared either for use or pleasure. Already the Société Zoologique d'Acclimatation extends throughout the entire world. We have recently mentioned the successful efforts of this society to introduce the dromedary into the desert plains of Brazil.

The Arch-Duke of Austria has sought instruction for making experiments of acclimation in the Isle of Crôma: also an Italian silk culturer favored by the relations of this Society, has succeeded in penetrating the silk districts of China, and has spent nearly two months near the city of Ouchau-fu, and has learned many of the processes employed in that country in the culture of the silk worm. It being impossible to reproduce here the interesting report which Castellani has addressed to the Society we refer the reader to the *Bulletin de la Société Zoologique*

* Biographisch-litterarisches Handworterbuch, par Poggendorff, 1858.

† See this Journal, [2], xxviii, p. 431.

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d'Acclimatation, where he will find, besides this memoir, other reports, as that of Guérin Mannaville concerning the important subject of silk and the insects which produce it.

During the sojourn of Castellani in China he learned the important fact that in that country no species of silkworm is reared in the open air; for those worms which are not devoured by birds soon perish if they do not receive that intelligent care which the Chinese from time immemorial have learned to give them. The contrary has been long maintained, and it was upon a belief of such reports that they endeavored in France to rear the Bombyx Cynthia in the open air. The Bulletin de la Société d'Acclimatation contains many notices of almost complete success of experiments undertaken in the early part of the year 1859. The Bombyx Cynthia feeds upon the leaf of the *Aylanthus glandulosa*.

The Serimetre.—We cannot leave the subject of silk without mentioning the interesting machine invented by Froment for the purpose of determining *the relative tenacity and elasticity of different kinds of silk*. This instrument measures at once, 1st. The tenacity of a thread by the weight necessary to break it. 2d. The elasticity, by the elongation it sustains before breaking.

We cannot here describe this instrument, but we may give an idea of the precision of its action by stating that it enables us to determine the tenacity and elasticity of a spider's web.

These researches have led to very curious results, of which the following possess the most general interest.

1. The climate, food, and general care have a considerable influence upon the tenacity of silk, for example, the cocoons raised in Avignon gave a tenacity of 12, while cocoons of the same species raised at Paris gave only 8.

2d. It appears that the male cocoons furnish silk finer and more tenacious than that of the female cocoons. Thus for an equal length the weight of the male cocoons being represented by - - - 11·28
That of the female cocoons was - - - - - 11·59
Again a mean of 200 experiments gave for male cocoons a tenacity of - - - - - - - - - 10·63
For female cocoons the tenacity was - - - - 9·80

By reason of the small difference between these numbers the results are for the present offered with some degree of doubt, but the Société d'Acclimatation has taken measures for removing these doubts. The *Sericometric* experiments, which we have mentioned, were made under the direction of Persoz, from whose report we have taken them.

Pseudomorphism and Pseudomorphosis.—Metamorphism, considered in the most general manner, comprehends all the modifications experienced by mineral substances; the subject may be divided according as it relates to minerals or to rocks. The first—the metamorphism of minerals—has been made, by A. Delesse the subject of profound study, which he has distinguished by the name of *pseudomorphism*. When a mineral is presented under a form which does not properly belong to it there is said to be pseudomorphism. The substance to which a mineral imparts its form may vary; it may even be of an organic nature, for a

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mineralogist sees a case of pseudomorphism even in a bone, phosphate of lime is not there found in its usual form.* Delesse makes a distinction between the original or substance *pseudomorphosed*, and the *pseudomorphic* or mineral substance which replaced the first.

He also distinguishes between *pseudomorphism by alteration* and *pseudomorphism by displacement;* in the former the pseudomorphic mineral contains the elements of the first substance; in the latter the first substance has completely disappeared. For example, iron pyrites which changes into hydrous oxyd, preserving its form becomes pseudomorphic *by alteration*, while fluor spar which is replaced by quartz, is pseudomorphic *by displacement*.

Delesse arranges among pseudomorphs, the forms by *envelopment*, so well described in Prof. Dana's Mineralogy; also those phenomena which Naumann has called *zoomorphosis* and *photomorphosis*, produced when organic matter is replaced by a mineral substance† or by other matter in a different condition.

Thus vivianite is sometimes developed in the interior of bones, in the shell of mollusks and in vegetables. Prof. Dana has seen it completely replace the calcareous beak of belemnites, and I myself have seen it developed in human bones buried in ferruginous soil; a part of this phosphate had even crystallized in the form of vivianite (see this Journal, [2], xxi, p. 402), even coal sometimes pseudomorphs certain fishes into cupriferous and bituminous slates (as those of Mansfeld.)

The simple bodies are rarely pseudomorphic; they are more frequently pseudomorphosed; for the most part there is no relation between the composition and form of pseudomorphosed bodies and pseudomorphic bodies, so also the composition of bodies appears to be without influence upon forms by envelopment.

Pseudomorphism by alteration is more frequent than pseudomorphism by displacement, inasmuch as the mineral newly formed more frequently depends upon the more ancient. The same mineral may be pseudomorphic or pseudomorphosed, without the existence of any rule in this respect, this condition is often presented by such minerals as quartz, carbonate of lime and pyrites as they occur in nature. Delesse has found among 105 pseudomorphic minerals and 119 pseudomorphosed minerals, or 224 in all, only 60 minerals that are both pseudomorphosed and pseu-

* Grasses and lichens belong to this class; the first owe their structure to silica, the others to oxalate of lime. A parallel generalization is evidently an exaggeration; these organic forms have been produced under the influence of life, and according to an invariable type, very unlike those pseudomorphs or forms obtained by epigenesis.

† To us the Saurian does not appear more different from a bird than the paramorphic bodies arranged in this category of Delesse. Laurent is the author of paramorphism, who defined it as follows: "I place in this class those bodies which have a different composition and which are isomorphic but in different systems," thus octohedric AsO_3 is paramorphic with prismatic SbO_3, and prismatic AsO_3 is paramorphic with octohedric SbO_3, &c.—(*Laurent, Méthode de Chemie*, 1854, p. 172.)

It is much to be regretted that Delesse was not acquainted with the researches of Prof. Cooke on allomerism (see this Journal [2], xxx, p. 194, and *Journal de Chemie et Pharmacie*, t. xxxviii, p. 383). The ideas of Prof. Cooke explain very well the difficulties met with by Delesse and other mineralogists. J. N.

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domorphic. Now admitting that the total number of minerals known is 642, the proportion of minerals in which pseudomorphism is found reaches one-fourth this number.

In this connection we may remark that these minerals are found for the most part in the metalliferous rocks.

The question of Inundations.—This important question, which has always been studied in France, has made considerable progress—a new cause of inundations has been discovered. The author of this discovery is an engineer, M. Gueymard of Grenoble, who has studied the Alps for nearly 50 years. In his opinion this cause is the absence of grass upon the sides of mountains. It existed at the commencement of this century but it has been destroyed by the great numbers of sheep pastured upon the mountains. Where grass was found fifty years ago the slopes are now denuded, and incapable of retaining the waters which have fallen in rain. Wherever there is a surface of sod 10 centimetres thick, for example, containing 10 per cent of water, it will absorb a layer of water 4·75 centimetres deep. Gueymard has concluded that the inundation which on the 30th of May, 1856, overflowed the valley of the Isère would have caused no damage if the slopes of the mountains had presented to the torrent of rain a covering of grass 20 centimetres in thickness, the earth would then have absorbed a layer of water 9·5 centimetres deep and the evil would have been averted.

The principal remedy for inundations is therefore to be found in *turfing*. Gueymard estimates ten years as the time necessary to produce upon the flanes of mountains a sod of sufficient consistence to resist effectually long continued rains.

He does not believe that destroying the forests upon mountains is the principal cause of inundations. He bases his opinion upon the fact that although there were no inundations in France from 1793 to 1840, the period during which the forests destroyed during the Revolution and restocked at the commencement of this century had not attained their full growth, yet the disasters of 1840 commenced when the forests had attained their full strength. But from 1800 to 1840, the flocks of sheep were increased three-fold, and in proportion as the trees increased in size the grass disappeared under the teeth of the animals, and with it the most efficient protection against inundations.

The French government has taken these observations under serious consideration, and made them the subject of careful study.

Bibliography.

BOSSANGE, *Paris*, has recently published:

Zoologie du Jeune Age, par Docteur LEREBOULLET, Professor de Zoologie à la Faculté des Sciences de Strasbourg.—This is a beautiful volume in quarto with colored figures. Professor Lereboullet is one of the most distinguished Zoologists in France. A considerable part of this work is elementary and in the form of lectures.

La Chimie Organique fondée sur la Synthese, par MARCELLIN BERTHOLLET, 2 vols. in 8vo, 1860. [This work is noticed above, p. 270.]

Les Electro-animants et l'adhérence Magnetique, par J. NICKLÈS.—This is a work almost entirely new, and full of facts not before published, (see this Journal [2], XXX, p. 413).

Notions de Physique, par POUILLET, 3d edition in 12mo.—This is a very excellent elementary work for those who are commencing the study of Physics.

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Das Buch der Natur, par Dr. Fdk. Schoedler, 11th edition, 2 vols. 8vo.—This is a work of the same class as the preceding but much more complete, for it embraces not only physics, but physical geography, astronomy and chemistry. The first edition appeared in 1844, and was received with such favor that it has passed through eleven editions in sixteen years.

Etudes Physiologiques sur les Animalcules des Infusoires Végétales, par Paul Laurent, Professor a l'Ecole Forestière de Nancy. 2 vols. in 4to with numerous illustrations. This work has acquired much importance from the recent discussions upon spontaneous generation. M. Laurent has given the results of 25 years of observation. The first volume is entirely devoted to infusoria, the second volume treats especially of the elementary organs of vegetables.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a Compound of Boron with Ethyl.*—Frankland and Duppa have succeeded in forming a combination of ethyl and boron by the action of zinc-ethyl upon boric ether. The reaction is represented by the equation

$$2(BO_3.3C_4H_5O)+3Zn_2(C_4H_5)_2=2B(C_4H_5)_3+6C_4H_5O,ZnO.$$

and is particularly interesting as offering a new method of forming compounds of the elements with compound radicals. When zinc-ethyl is brought in contact with tribasic boric ether the temperature rises gradually during half an hour. On submitting the liquid to distillation a colorless liquid passes over between 94° and 120°. The distillation is then to be interrupted. The remainder in the retort solidifies to a crystalline mass, which is a combination of ethylate of zinc and zinc-ethyl. The distillate after two rectifications, boils between 95° and 97°. It then corresponds to the formula $B\begin{cases}C_4H_5\\C_4H_5\\C_4H_5\end{cases}$. Borethyl is a colorless soluble liquid which has a sharp odor: its vapors strongly irritate the mucous membranes and provoke a flow of tears. Its density is 0·6961 at 23°: it boils at 95°; the density of its vapor is 3·4006. The theoretical vapor-density, calculated according to the condensation of chlorid of boron, would be 3·3824.

Borethyl is not easily decomposed by water, in which it is insoluble. The liquid itself takes fire spontaneously in contact with the air and burns with a magnificent green and smoky flame; in contact with pure oxygen it explodes. When submitted to slow oxydation it forms a colorless liquid boiling at higher temperature than borethyl, but which cannot be distilled at ordinary pressures. By distillation in vacuo, this liquid may be obtained pure, and its constitution is then expressed by the formula $B\begin{cases}C_4H_5\\C_4H_5O_2\\C_4H_5O_2\end{cases}$.

This compound dissolves immediately in water, decomposing into alcohol and a white crystalline substance which may be sublimed without alteration in a current of carbonic acid gas. It then forms magnificent

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acales like those of naphthaline. Its constitution is represented by the formula $B\left\{\begin{matrix}C_4H_5\\HO_2,\\HO_2\end{matrix}\right.$ and its formation depends evidently on the substitution of two atoms of hydrogen for two atoms of ethyl in the compound $B\left\{\begin{matrix}C_4H_5\\C_4H_5O_2.\\C_4H_5O_2\end{matrix}\right.$ This substance possesses an agreeable ethereal odor, and a very intense sweet taste. When exposed to the air, it volatilizes slowly at ordinary temperatures, and is partially decomposed, always leaving a little boric acid. Its vapor possesses an intense sugary odor; it reddens litmus paper, although its other acid properties are but feeble. Water, alcohol and ether easily dissolve it; it melts at a gentle heat, and boils at a high temperature, with partial decomposition.

The authors promise an extended study of these substances as well as of the reactions of zinc-ethyl with silicic, carbonic and oxalic ethers.—*Ann. de Chimie et de Physique*, lx, 374, November, 1860. W. G.

2. *On the vapor-density of Chlorous Acid.*—The vapor-density of chlorous acid was found by Millon to be 2·646. This corresponds to a condensation from 5 volumes to 3; the calculated vapor-density is then 2·7454. According to this determination, chlorous acid forms a remarkable exception to the law now generally assumed that all substances in the state of vapor correspond to 2 volumes; it also renders it necessary to consider the atomic weight of oxygen 8, and not 16.

Schiel has therefore undertaken a new determination of the vapor-density of the acid, and finds in two experiments the numbers 2·723, and 2·603, which corresponds closely to the determination of Millon. The author proposes to control these determinations by observing the ratio of the volumes of chlorine and oxygen which are obtained from a known volume of the acid.—*Ann. der Chimie and Pharm.*, lxvi, p. 115.

W. G.

3. *New Researches on the Oxyd of Ethylene.*—Wurtz has communicated some exceedingly interesting and important results of his continued investigations of the ethylene series. These may be briefly stated as follows: 1. Oxyd of ethylene unites directly with acids and neutralizes them. When the oxyd is heated in a water-bath with concentrated chlorhydric acid, the two unite directly forming chlorhydrate of oxyd of ethylene. The oxyd unites in like manner with anhydrous or hydrous acetic acid, and gives among other products the neutral acetate. 2. In uniting with acids the oxyd of ethylene is capable of forming basic salts. Thus in the last experiment, after separating the neutral acetate by distillation, there remains a considerable quantity of a liquid boiling above 200°.

This contains three products which may be considered as basic acetates of oxyd of ethylene, and which constitute in reality the acetates of polyethylenic alcohols. The first boils at about 200°, and constitutes diethylenic acetate, which is formed in consequence of the following reaction:

$$2(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,\ 2C_4H_4O_2=(C_4H_3O_2)_2\left\{\begin{matrix}C_4H_4\\C_4H_4\end{matrix}\right\}O_6.$$

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When saponified by baryta, this acetate is resolved into acetic acid and diethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_2\\H_2\end{matrix}\right\}O_2$

The second product boils toward 290°, and constitutes triethylenic acetate.

$$3(C_4H_4O_2)+C_6H_6O_6=C_6H_6O_6,3C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

Under the influence of baryta it yields acetate of baryta and tri-ethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_3\\H_2\end{matrix}\right\}O_3$. Finally, the third product boils above 200°, and when distilled in vacuo is a thick colorless liquid, tetrethylenic acetate.

$$4(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,4C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_{10}.$$

Baryta transforms this into acetate of baryta and tetrethylenic alcohol. This last is a thick colorless neutral liquid, soluble in water and boiling above 300°.

Oxyd of ethylene is also capable of combining with diacetic glycol to form polyethelenic acetates.

$$C_4H_4O_2+\left.\begin{matrix}C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_4=\left.\begin{matrix}C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_6.$$

This reaction is comparable with that which transforms acetate of lead into basic acetate, when the neutral salt is brought into contact with an excess of oxyd of lead.

$$2(Pb_2O_2)+\left.\begin{matrix}\overset{''}{Pb}\\(C_4H_3O_2)_2\end{matrix}\right\}O_2=\left.\begin{matrix}\overset{''}{Pb}_3\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

The basic properties of oxyd of ethylene are especially shown in the action which it exerts upon saline solutions. When the oxyd is mixed with a concentrated solution of chlorid of magnesium, the liquid after some hours solidifies; magnesia is precipitated, while chlorhydrate of oxyd of ethylene is formed.

The oxyd on the contrary is displaced by potash, when this is made to act upon the chlorhydrate. Heated upon a water-bath with a solution of perchlorid of iron, the oxyd of ethylene precipitates the hydrate of the sesquioxyd: it also precipitates alumina from a solution of alum and subsulphate of copper from a solution of the sulphate. These facts exhibit clearly the basic properties of oxyd of ethylene, which is comparable with the anhydrous oxyd of zinc, or oxyd of lead, while glycol itself corresponds to the hydrates of these oxyds.

$$\left.\begin{matrix}\overset{''}{Zn}\\H_2\end{matrix}\right\}O_2,\qquad\left.\begin{matrix}\overset{''}{Pb}\\H_2\end{matrix}\right\}O_2,\qquad\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_2.$$

—*Repertoire de Chimie Pure, Sept.* 1860, p. 340. W. G.

4. *Transformation of Olefiant Gas into complex Organic Acids.*—In his memoir on the glycols, Wurtz had expressed the opinion that these might

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be considered as the alcohols of diatomic acids: the following facts serve to confirm this view. By oxydizing diethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6$ he has obtained an acid isomeric with malic acid, and under the same circumstances, has transformed triethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8$ into a still more complex acid.

The oxydation of diethylenic alcohol is easily affected by nitric acid which acts very violently; the acid liquid crystallizes when evaporated. The liquid is to be saturated with milk of lime, when a small quantity of oxalate of lime separates. The filtrate yields a lime salt in long and brilliant needles, which has the formula $C_8H_4Ca_2O_{10}+12HO$.

The acid is most easily prepared by decomposing the silver salt with sulphydric acid gas; the solution deposits voluminous crystal after concentration. The new acid crystallizes in large rhomboidal prisms, possessing a distinct acid-taste. It is very soluble in water or alcohol; its composition is expressed by the formula $C_8H_6O_{10}+2HO$.

When distilled, it yields a thick liquid which crystallizes after some time, and which constitutes a true pyrogenic acid. When fused with hydrate of potash, hydrogen is given off, while acetic and oxalic acids are formed. Wurtz considers it probable that this acid is identical or isomeric with an acid obtained by Heintz as an accessory product in the preparation of glycolic acid, by means of monochloracetic acid and hydrate of soda.

In the oxydation of triethylenic alcohol two acids are obtained, one of which is identical with that just described; the other has the formula $C_{12}H_{10}O_{12}$. This acid does not crystallize, but after separation remains in the form of a syrupy mass.

The author remarks that in the oxydation of the polyethylenic alcohols a certain quantity of hydrogen disappears and is replaced by an equivalent quantity of oxygen. We may admit that the two acids just described are derived from two corresponding alcohols, just as glycolic acid is derived from ethylenic alcohol, by the transformation of a certain number of molecules of ethylene, C_4H_4, into glycolyl, $C_4H_2O_2$, as the following formulas show.

$\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_4$	$\left.\begin{matrix}C_4H_2O_2\\H_2\end{matrix}\right\}O_4$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6$	$\left.\begin{matrix}C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_6$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8$	$\left.\begin{matrix}C_4H_4O_2\\C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_8$				
Glycol.	Glycolic acid.	Diethylenic alcohol.	Diglycolic acid.	Triethylenic alcohol.	Dyglycol-ethylenic acid.				

These acids possess the molecular composition and the characters of the vegetable acids; they are obtained synthetically from olefiant gas, which is successively transformed into bromide of ethylene, glycol, oxyd of ethylene, polyethylenic alcohols, and finally into diglycolic and diglycolethylenic acids.—*Rep. de Chimie, Pure, Sept.* 1860, p. 342 W. G.

5. *On the determination of Phosphoric Acid.*—The process of Chancel for the determination of phosphoric acid by means of the acid nitrate of bismuth, has already been described in this Journal (vol. xxx, 122). The author now gives further details which are necessary to ensure the success

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of the method, especially when iron is present. In this case, the precipitated phosphate of bismuth always contains iron, unless this metal is present in the form of protoxyd. The process to be pursued in general is as follows: 1. Treat the weighed substance with an excess of concentrated nitric acid by the aid of heat, so as to transform, if necessary, metaphosphoric or pyrophosphoric acids into tribasic phosphoric acid; redissolve by a sufficient quantity of nitric acid, add water, and filter if necessary. 2. Remove the sulphuric acid from the dilute solution by nitrate of baryta, then the chlorine by nitrate of silver. 3. Pass a current of sulphuretted hydrogen to saturation through the filtered liquid. In this manner the iron is completely reduced to protoxyd, even when the liquid contains a large quantity of free nitric acid, while silver and other metals which give insoluble sulphides are completely precipitated. Before filtering, the sulphydric acid gas must be completely removed by passing a current of carbonic acid through the liquid, till the gas no longer darkens paper soaked in acetate of lead. 4. An excess of acid nitrate of bismuth is then to be added to the filtered liquid, the precipitate allowed to settle, collected on a filter, washed with boiling water, dried, ignited and weighed. 5. The bismuth may then be removed from the filtrate by means of sulphuretted hydrogen, and the bases present determined in the ordinary manner. —*Comptes Rendus*, li, 882. W. G.

[See on p. 281 an interesting note on this subject by Mr. McCurdy.]

6. *On the preparation of Oxygen.*—H. St. Clair Deville and Debray, in studying the economical production of oxygen upon the large scale, have arrived at results which promise to be of great practical importance. The authors find that sulphate of zinc when heated alone in an earthen or porcelain vessel yields a light and white oxyd which may be utilized in painting; sulphurous acid, which is easily absorbed by water; and finally pure oxygen. The temperature required is not much higher than that which is necessary for the decomposition of peroxyd of manganese.

Another and very elegant process, consists in the decomposition of sulphuric acid by heat. A fine stream of the acid is allowed to flow into a retort of about five litres capacity, filled with thin platinum foil and heated to redness. The acid is completely decomposed into oxygen, water and sulphurous acid, which last is absorbed by an appropriate washing apparatus. The sulphurous acid may again be converted into sulphuric acid, in the usual manner.—*Comptes Rendus*, li, 822. W. G.

7. *On the Polyethylenic Alcohols.*—Lourenço has studied the action of bromid of ethylene upon glycol, and has discovered several new polyethylenic alcohols closely related to those already described by Wurtz. The diethylenic, triethylenic and tetrethylenic alcohols of Wurtz are among the products of the reaction and may be separated by a fractional distillation. In addition to these, the two alcohols belonging to the same series are formed. Pentethylenic alcohol whose formula is

$$\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_{12} = C_{20}H_{22}O_{12}.$$

is a viscid liquid like glycerine, soluble in water, alcohol and ether, and boils at about 281° under a pressure of 0·025^{mm}, that is to say almost in vacuo.

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Hexethylenic alcohol is only to be distinguished from the last by its greater viscidity. It boils at about 325° under the same pressure of 0·025^{mm}. Its formula is $\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_{14}=C_{24}H_{26}O_{14}$.

When the operation is conducted for a sufficiently long time and an excess or glycol is employed, other alcohols of the same series are obtained, the general formula being $\left.\begin{matrix}{}^{n}C_4H_4\\H_2\end{matrix}\right\}O_{2n+2}$.

The compounds become more and more viscid as their molecular complication increases. We remark a difference of about 45° in their boiling points. When the mixture of bromid of ethylene and glycol is heated above 130°, very different results are obtained. The liquid becomes brown and the alcohols disappear, giving rise to the corresponding bromhydric ethers.—*Comptes Rendus*, li, p. 365. W. G.

7. *On Baudrimont's Protosulphid of Carbon.*—PLAYFAIR has examined the different processes given by Baudrimont, for the preparation of the protosulphid of carbon. These processes are not less than five in number; though the author admits that only the first yields the compound in a state of tolerable purity. This process consists in passing the vapor of bisulphid of carbon over red hot pumice stone or spongy platinum, by which, according to Baudrimont, sulphur is deposited and the gaseous protosulphid set free. Playfair found on repeating this process that no protosulphid of carbon whatever is formed, but that the gas given off consists of carbonic oxyd and nitrogen; while the greater proportion of the bisulphid of carbon passes over undecomposed. In like manner it was found that when the vapors of bisulphid of carbon were passed over red hot charcoal, only a mixture of carbonic oxyd, nitrogen and bisulphid of carbon was obtained. The author concludes that there is no sufficient evidence of the existence of protosulphid of carbon, all the processes described for its preparation, having failed to yield it.

W. G.

ANALYTICAL CHEMISTRY.

Contributions from the Laboratory of the Yale Scientific School;—communicated by Profs. BRUSH *and* JOHNSON.

8. *Observations on Chancel's method of estimating phosphoric acid;* by HENRY L. MCCURDY.—The following new method for the detection and quantitative separation of phosphoric acid by means of nitrate of bismuth has been lately recommended by Chancel as of universal applicability. A nitric acid solution of the substance containing phosphoric acid is treated with a solution of nitrate of bismuth* as long as a precipitate is formed.

* Best prepared, according to Chancel's latest advice, by dissolving 68·45 gms. of the pure crystallized neutral nitrate of bismuth, $BiO_3 3NO_5+10aq$ in a quantity of nitric acid representing 68·5 gms. of anhydrous nitric acid and bringing the solution to the volume of a liter. Each cubic centimeter of this solution precipitates 1 centigram of phosphoric acid.

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It is then boiled, filtered and the precipitated phosphate of bismuth is washed with hot water, dried, ignited and weighed. Chlorine and sulphuric acid, if present, must first be removed by means of the nitrates of baryta and silver. Too great an amount of nitric acid must be avoided, since the phosphate of bismuth though insoluble in a moderate quantity of nitric acid, is soluble in a large excess.

I have recently made some experiments on this method, at the suggestion of Prof. Johnson, which go to show that in the presence of certain sesquioxyds it is utterly valueless. I proceeded as follows: a solution of nitrate of bismuth was prepared according to Chancel's directions, and also a solution of pure phosphate of soda. These two solutions were of such strength that one cubic centimeter of the nitrate of bismuth solution contained a little more bismuth than was necessary to precipitate the whole of the phosphoric acid in 1 c. c. of the phosphate of soda solution.

A strong solution of the nitrate of the sesquioxyd of iron was then prepared, and to 1 c. c. of it were added successively 1 c. c. of the phosphate of soda solution and 1 c. c. of the nitrate of bismuth solution. No precipitate was formed even after boiling the mixture. The pernitrate of iron was diluted with nine parts by volume of water, and to 1 c. c. of this dilute solution were added equal amounts of phosphate of soda and nitrate of bismuth. A rather bulky precipitate came down, but after boiling, the filtrate on being tested with molybdate of ammonia was found to contain phosphoric acid in large quantity. The experiment was repeated, using two, three and four c. c. of the dilute solution of ferric nitrate to 1 c. c. each, of the solution of phosphate of soda and nitrate of bismuth with similar results—the precipitate of phosphate of bismuth diminishing and the amount of phosphoric acid in the filtrate increasing regularly as more and more of the iron salt was added. When 5 c. c. of the solution of iron were employed to 1 c. c. each, of the two other solutions, there was no precipitate whatever, the whole of the phosphate of bismuth being held in solution by the nitrate of iron.

In all cases where phosphate of bismuth was precipitated in presence of nitrate of sesquioxyd of iron it carried down with it a notable quantity of iron, as manifested by the color of the precipitate, which was brownish red when a large proportion of iron existed in the solution and of a yellow tint when the amount of iron was small.

A strong solution of nitrate of alumina was prepared by saturating nitric acid (of sp. gr. 1·16) with pure, freshly precipitated hydrate of alumina, and some experiments were made with this solution, using in each case, 1 c. c. of the solution of phosphate of soda and 1 c. c. of the solution of nitrate of bismuth, to successively increasing quantities of the nitrate of alumina. With 1 c. c. of the nitrate of alumina solution there was formed a considerable precipitate, but when the solution was filtered, and tested with molybdate of ammonia it was found still to contain phosphoric acid. After dissolving this precipitate in hot nitric acid and separating the bismuth by sulphuretted hydrogen, ammonia indicated the presence of phosphate of alumina, showing that the phosphate of bismuth had carried down a portion of alumina with it. With 2 c. c. of nitrate of alumina there was scarcely any precipitate on boiling, and with 3 c. c. the phosphate of bismuth was entirely prevented from separating.

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Experiments were made with a solution of nitrate of sesquioxyd of chromium and it was found that 5 c. c. of chromic nitrate employed to 1 c. c. each, of the solutions of phosphate of soda and nitrate of bismuth, were sufficient to prevent the formation of any precipitate. The solution used was a rather strong one.

Nitrate of sesquioxyd of uranium even in small quantities prevents the complete precipitation of phosphoric acid by this method, and when in large amount, dissolves the precipitate entirely. The phosphate of bismuth when thrown down from a solution containing uranic nitrate is contaminated with the latter.

A similar series of experiments was made with the nitrates of ammonia, potassa, baryta, strontia, lime, and magnesia. The presence of these bases does not seem to interfere with the success of the method.

It follows from these trials that the method proposed by Chancel, can not be applied in the presence of sesquioxyds of iron, aluminum, chromium or uranium, since, on the one hand the nitrates of these substances when in excess, have the property of dissolving phosphate of bismuth and thus preventing its precipitation, and on the other, when phosphoric acid is in excess, phosphates of these bases are thrown down in conjunction with the phosphate of bismuth.

Note.—Since these experiments by Mr. McCurdy were completed, we have learned from the *Comptes Rendus* that Chancel has discovered the inapplicability of his original method in presence of peroxyd of iron, and proposes to overcome this difficulty by reduction of the peroxyd to protoxyd. The details of the modified process are given on page 279. Chancel, however, still appears to overlook the fact that his process is, and is likely to remain valueless in just those cases where a new method would be most acceptable, viz. for the estimation of phosphoric acid in presence of alumina. S. W. J.

Yale Scientific School, Feb. 15, 1861.

TECHNICAL PHYSICS.

9. *On the loss of Light by Glass Shades.*—(To the Editor of Silliman's American Journal of Science and Arts)—*Sir:* In the November number of your Journal I find a notice of my experiments on the loss of light by glass shades, with an account of additional investigations by Mr. Frank H. Storer; his communication induces me to offer some further remarks on the subject.

The experiments were intended to be of a practical nature, and were tried solely in order to ascertain, (as I state in my letter to the London Journal of Gas Lighting), the loss of light occasioned by the use of the ordinary glass shades. It is not therefore quite correct for Mr. Storer to compare results obtained by the use of *flat sheets*, with the loss of light occasioned by *spherical shades*. He is right however in supposing that by "the loss of light," I intended to express "the actual diminution of the amount of light, falling for example, upon the pages of a book held near to its source, which would be occasioned by the interposition of the shades enumerated."

Prof. Verver had another object in view, and his experiments do not apply to this subject. *He* was investigating the illuminating power of gas when burnt in an Argand burner with, and without, a chimney. The

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gas in these two cases is burnt under very different conditions, while in Mr. Storer's experiments, and those which I have tried, the gas was burnt under precisely the same circumstances whether a shade was interposed or not, the only difference being in the substances through which the light was transmitted.

I conducted my experiments in the following manner:—In order to avoid the trouble and inaccuracy arising from the use of a candle, I employed a gas-light as the standard of comparison throughout the trials of all the shades. This could easily be done, as in the blackened experiment chamber of the Liverpool United Gas Light Co., there is a duplicate set of apparatus, two governors, metres, burners, &c., being fixed at opposite sides of the room.

The lights, (which we may call A and B), having been made equal and their respective consumptions noticed, the first shade, (that of clear glass), was placed surrounding A, and the photometer screen moved towards it, until both sides of the screen were equally illuminated, the reading on the photometer staff was then found to be 1·118 on that side of the centre of the staff nearest A, or, in other words, the proportion of light given by B, (without a shade), was to the light given by A, (with a shade), as 1 to $\frac{1}{1\cdot118}$ or as 1 to 0·8944, or the loss of light by the use of the shade was equal to 10·56 per cent. The first shade was then removed, and the next substituted, and so on till the loss of light in each case was determined.

After all the shades had been examined, the lights were again compared, and found to be equal as at first adjusted. The quality of the gas and the descriptions of burner employed do not affect the question, provided that the same burner is used throughout all the experiments. The burners I used were "No. 3, Fish-tails," consuming 3·7 cubic feet per hour. The gas was taken from the street mains.

By using a standard light of unvarying intensity, all the errors likely to arise from inequalities in the consumption of a candle are avoided, and much time is saved in making the experiments as one or two observations with the photometer in each case are quite sufficient to ensure accuracy.

The divisions on the photometer staff do not necessarily represent candles, but the proportion that one light under examination, bears to the other, when one of them is taken as unity.

I may observe that the single experiment made with a *sheet* of common window glass was tried simply to confirm the result obtained by the globe of clear glass.

The distance at which the glass is placed from the light does not seem in the slightest degree to affect the amount of light transmitted through it. I am glad to find that my own experiments on this point are so entirely confirmed by Mr. Storer's statement. WILLIAM KING.

Liverpool United Gas Light Co., Dec. 28, 1860.

NOTE BY MR. STORER.

In reply to the courteous letter of Mr. King, I must express my regret that he has not more explicitly stated the reasons which led him to object to a comparison of results obtained by the use of flat sheets of glass with those obtained when spherical shades are employed. That the light which is reflected back from the interior

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surface of one side of a lamp-shade, of any form, would be compensated for by that similarly reflected from the opposite side—and that no similar compensation could occur in my own experiments where only single sheets of glass were used,—is evident; but I am ignorant of any experiments which go to show that the amount of light which is cut off from a given surface by the interposition of a *flat* screen is different from that which would be stopped by a *curved* screen *of the same material*. Let us suppose a precise example; in a large sheet of blackened tin we cut out an aperture, say of three or four inches diameter, and cement therein a flat sheet of ground glass and, having interposed the apparatus between a flame and the photometer, determine how much light is cut off by the glass, *i. e.*, bring the photometer to rest, as it were:—if now, having done this, we remove the flat sheet of glass and fasten in its place a segment of a lamp-shade of a material identically similar with that of the flat sheet first used, shall we find that our photometer is no longer in equilibrium? The same amount of light must have in each instance passed into the aperture in the sheet of tin;—why should it not be transmitted to our photometer in the same way in either case? The experiment cited would probably be difficult to carry out in practice since it would not be easy to find curved and flat screens of ground glass of precisely the same material, or ground equally rough. I state it merely in order that the conditions of the problem may be clearly understood, and with the desire that some proof may be given that the transmitted light would be less in one case than in the other,—a supposition not in accordance with received theories (see Art. Light in Encyclopædia Metropolitana, p. 347, §§ 42, 43); nor would it be inferred from what is known of the analogous case of radiant heat, (see LAMÉ, *Cours de Physique de l'Ecole Polytechnique*, 2 e Edit. Paris, 1840, i, 309).

On the other hand, looking at the question in its practical bearing, it is clear that all lamp shades are not spherical. Witness, for example, the flat sheets of colored or ground glass used by the cars upon our street railways, the flat sheets of plain glass of the street gas lanterns, and the flat sheets of ground, enameled, or colored glass in the out-of-door lanterns of eating houses, &c.; to say nothing of the shades constructed of flat porcelain transparencies which are so commonly employed in this country to soften the glare of gas-lights; or of the lanterns of colored and enameled glass which were so often exhibited in the torch light processions of the Presidential campaign of the Autumn of 1860, and by which the phenomenon, of "loss of light by glass shades," now under discussion was so strikingly exhibited. In instituting a new series of observations, I therefore chose to make experiments, the results of which might be added to those of Mr. King, rather than to repeat the work which he had already so faithfully performed. In publishing my results, I regarded them as being merely supplementary to those of Mr. King, neither intending to institute any comparison between the two series of observations, nor directly to compare his spherical shades with my flat sheets. I intended to state only that my own experiments corroborated those of Mr. King in so far as they went to prove the *great loss of light* occasioned by the use of glass screens.

As for the experiment of Prof. Verver, to which Mr. King takes exception, he must pardon me, if I persist in maintaining that the observation does apply to the question at hand. It matters little in science, at any time, what *object* an experimenter may have in view, so long as the truth is attained and exhibited by his researches; but in the case in point, Verver's experiment, so far as it goes, applies directly to our subject. (See his own words, this Journal, Nov., 1860, [2.] xxx, 421.) Since, as I remarked in my previous note, the gas was indeed burned under somewhat different conditions in the two stages of Verver's experiment, his result must consequently be regarded as merely approximative; but before seeking to discard it altogether, Mr. King should have remembered that a globular glass shade surrounding a fish-tail burner is in some measure a *chimney*, and that therefore his own results cannot well be *entirely* exempt from the same source of error which affects the experiment of Verver. In making this remark, I would not in the least degree imply that Mr. King's observations are not most excellent. For my own part, I entertain no doubt of their accuracy;—for, throwing out the conceivable slight error to which I have alluded, his method of experimenting is unquestionably the best which is yet known. I urge only that the observation of Verver, must not be rejected.

FRANK H. STORER.

Boston, Feb. 6, 1861.

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TECHNICAL CHEMISTRY.

10. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (From the Memoirs of the American Academy, [N. S.,] vol. viii, p. 27),* Cambridge, 1860, pp. 32, 4to.

In the words of the author:—"This research was undertaken in order to ascertain what, if any, definite chemical compounds could be detected among the alloys of copper and zinc."

"Several chemists had already been led to believe in the existence of two or more definite alloys, and at the commencement of my own labors I was strongly inclined to accept this view. A more extended investigation, however, has convinced me that no such definite compounds exist. On the contrary I am confident that all the alloys of copper and zinc are simply isomorphous mixtures of the two metals, capable, as I shall proceed to show, of crystallizing at any point, from copper with only a trace of zinc down to alloys containing but thirty per cent of copper, or even less, under favorable circumstances." "The misconceptions of previous observers† have evidently arisen either from a great tendency to separate into layers, instead of immediately forming a homogeneous mixture, which the metals exhibit when fused together, or from certain striking peculiarities of structure and of superficial coloration which occur among the d fferent alloys."

Mr. Storer has prepared a large number of alloys of copper and zinc containing different proportions of these ingredients, by methods which he has described in detail, and has found that they may all be crystallized by piercing the crust which forms upon the partially cooled molten metal and then quickly pouring off those portions of the latter which are still fluid from the crystals which have formed upon the walls of the crucible, —as in the common class experiment of crystallizing sulphur by fusion. At least he has succeeded in obtaining crystals from all the alloys which contain more than thirty per cent of copper. He has found it difficult, however, to crystallize any of the alloys which contain less than this proportion of copper since they are liable to pass through a pasty plastic state similar to that assumed by zinc or soft-solder while solidifying.

"These crystals are all octahedral, usually somewhat elongated and apparently much modified by the circumstances in which they have been formed. The edges of all of them are rounded. The octahedra are in general more largely developed upon one side than the other, apparently upon the side from which the last drippings of the melted metal fell. They are, moreover, combined together with parallel axes, which give to the crystals‡ a striated appearance; these striæ are not sharply defined,

* Communicated to the Academy, Nov. 9, 1859.

† "I must in this connection refer to and except, the valuable memoir of Karsten (*vid.* Karsten u. Dechen's *Archiv. für Mineralogie u. a. w.*, 1839, xii, 385), whose conclusions in regard to these alloys appear to be perfectly correct, with the exception of a few unimportant details. As is the case with the able research of the elder Mallet, the details of which are to be found only in the Report of the Tenth (Glasgow) Meeting of the British Association, for the Advancement of Science, p. 253, the very meagre abstracts of this memoir which are given in the chemical journals and text-books fail to convey a correct idea of the results which have been obtained,—a fact which may serve to explain the ignorance which has been exhibited, in regard to them, by subsequent experimenters."

‡ Figured in the memoir.

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but their edges have the rounded character of the edges of the crystals This general character is maintained throughout the whole series o crystals, from those of pure copper down to those of the lowest white alloys which I have obtained. No doubt can possibly be entertained of the complete resemblance of these crystals to each other throughout the series, while the striking similarity to the well-known crystals of pure copper (obtained by fusion) which they exhibit, strongly indicates that they belong to the regular system. As it is of course impossible to measure the angles of such crystals, they cannot be crystallographically determined; but the most obvious conclusion is, that they are monometric. This opinion, however, must be based rather upon analogy than on any distinct measurements.

"Upon the assumption that the crystals which I have described belong to the regular system, as well as upon the fact, which will appear in the sequel, that none of the crystals have been found to contain any larger quantity of either of their component metals than was contained in the remainder of the molten liquid from which they had separated, I have based my conclusion that the alloys of copper and zinc are isomorphous mixtures* of the two metals."

"On this hypothesis it is of course presumed that both copper and zinc are capable of crystallizing in the regular system. Copper, as is well known always occurs in forms of the monometric system. But in regard to zinc this has not been so satisfactorily proved. Not only, however, does analogy indicate that zinc should be monometric—for, so far as is known, all the metals of the Three Series of Cooke† allied to it crystallize in forms of this system—but Nicklès‡ has actually observed an instance in which it occurred in the form of pentagonal dodecahedrons."

This observation of Nicklès having been called in question by Nœggerath and G. Rose, Mr. Storer takes occasion to defend it, maintaining that it is entitled to as much confidence as any of the observations of the crystalline form of zinc which have hitherto been made.

A minute description with figures of the crystals as obtained from alloys of various composition follows. These crystals vary in size according as a larger or smaller quantity of the alloy is allowed to become solid before piercing its crust, some of those obtained by the author exceeded half an inch in length, others were quite minute.

"Very fine groups of crystals were obtained from those alloys which contained only one or two per cent of zinc. It is worthy of note, that, although these crystals have the same form and general appearance as those prepared by the same method from an equal quantity—three or four pounds—of pure copper, they are nevertheless much larger and more perfect. Since they may, for all practical purposes, be considered as crystals of copper with slight impurity of zinc, and are easily to be obtained,

* "It must not be supposed that this view supports in the least the idea of the older chemists, that alloys were mere 'mixtures' of their component metals. For the experiments of Karsten (*loc. cit.*, pp. 398, 400) have already shown that the comportment of the alloys of copper and zinc towards acids, and the solutions of various metallic salts, is that of chemical compounds, being entirely unlike that of a simple mechanical mixture of the two metals, or of a mixture of several alloys."

† Memoirs of the Amer. Acad., [N. S.,] v, table to p. 256.

‡ Ann. Ch. et Phys., [3,] xxii, 37.

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it would almost seem advisable to add one or two per cent of zinc to the metal employed in preparing specimens of crystallized copper for the cabinet. A similar case is presented by lead, which is very readily crystallized when it contains a little antimony: a fact well exemplified by the beautiful cups of crystals of *Krätzblei*, which are prepared by partially cooling the metal in ladles, at the Fraukensharner smelt-works near Clausthal, and doubtless in other localities in the Hartz."

"Since the crystals rich in copper which have just been described do not possess in any marked degree the yellow color peculiar to brass, they are somewhat less interesting than those obtained from alloys containing more zinc. Crystals of the latter can be obtained with the greatest ease by remelting old brass, or, better, by filling a Hessian crucible from the molten metal of the pots of a brass founder, in which case all annoyance from the formation of a false crust of mixed oxyd of zinc and metal is obviated." * * *

"The most perfect individual crystals were obtained from a quantity of brazier's solder which had been prepared at the foundry of the Revere Copper Co., in Boston, by fusing together 50 parts of copper with 50 parts of zinc. When an alloy of about this composition solidifies, and especially if it be suddenly cooled—as happens when it is poured into iron ingot-moulds,—it assumes, as is well known, a highly crystalline structure, consisting almost entirely of a mass of coarse fibres which shoot out from the points at which the alloy comes in contact with the cold metal of the mould. In the instances which have fallen under my notice the ingots being from an inch to an inch and a half in depth the fibres have shot up three quarters of an inch, or more, from the bottom of the ingot, leaving only a sheet of metal about a quarter of an inch in thickness on top, which had cooled more slowly by contact with the air. * * * On removing portions of this upper layer, its inferior surface will be found studded with crystals, often of great beauty, while others frequently occur impacted among the fibres themselves. Indeed, these fibres, although described by Calvert and R. Johnson* as prismatic crystals, indicating that the alloy Cu Zn is a definite chemical compound, are evidently nothing more than collections of octahedral crystals, similar to those which form the fibres of sublimed sal-ammoniac and of several metals."†

The tendency to shoot out into fibres just alluded to which extends over quite a space from alloys containing 57 or 58 per cent of copper down to those containing only 43 or 44 per cent is next discussed. It is of peculiar interest on account of its practical bearing;—"alloys at the upper limit of this fibrous tendency being the lowest—*i. e.*, richest in zinc—which can be rolled or subjected to the various processes by which metals are wrought. Singularly enough, at a point just beyond the limit at which the fibres cease to be apparent, viz., at 60 per cent of copper, an alloy of peculiar homogeneity occurs;—its fracture as seen when small bars are broken, being smooth and compact, and entirely unlike either the coarse, irregular, stringy fracture of alloys richer in copper, or that of alloys containing only a little more zinc, upon the fracture of which small bundles of fine crystalline fibres are often apparent.

* Journal of the Franklin Institute, [3,] xxxvii, 200. See also Phil. Trans., cxlviii, 367.

† *Vid.* Savart, Ann. de Ch. et Phys., [2,] xli, 65.

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"This alloy readily admits of being rolled, either hot or cold, and may be subjected to the operations of hammering or drawing without detriment, while alloys containing only a few per cent more copper can be rolled hot only when the sheets are raised to a very high temperature. * * *

"In the preparation of the alloy of 60 per cent copper, now so extensively used for sheathing vessels under the name of Muntz's sheathing or yellow-metal,—also known as malleable brass,—it is the custom of founders to reserve a portion of the zinc which has been weighed out for a charge, until the alloy in their pots or furnace has become sufficiently hot; the last portions of zinc are then added in small pieces, a sample of the alloy being tested after each such addition. This is done by dipping out a small portion of the melted mass and pouring it into a mould; a little ingot, five or six inches long by an inch or less in thickness, is thus obtained, which after cooling, is broken on an anvil, and its fracture observed. If this does not exhibit a smooth and homogeneous surface, more zinc is added to the alloy. The accuracy with which an experienced workman can thus obtain the desired alloy is truly astonishing, the more especially since this homogeneous alloy is confined within very narrow limits."

"It is stated by founders that the alloy of 60 per cent of copper and 40 per cent of zinc will present almost precisely the same homogeneity of fracture, whether the test ingot prepared from it be cooled slowly, by exposure to the air, or rapidly, by plunging it into cold water, while alloys containing either more or less than 60 per cent of copper are liable to assume different structures, according as they are cooled with greater or less rapidity. Two ingots are therefore sometimes cast, on each trial of the alloy, one of which is cooled in water and the other in air for comparison. This double test is, however, deemed superfluous by skillful workmen."

"I may remark in this connection, that I have repeatedly obtained crystals, by the method of partial cooling, from portions of melted yellow-metal taken from the founder's pots at the moment it had afforded them a satisfactory test. These crystals are in no wise different from those obtained by myself from alloys of almost identical composition.

"Although, as has been stated, the tendency to form fibres seems to have ceased at the alloy containing 60 per cent of copper, I cannot but think that the limit of its influence is less clearly defined than the "test" of yellow-metal founders would seem to indicate. In the circumstances under which this test is applied, it is doubtless true that no fibres are formed; but it is a matter of experience with manufacturers of yellow-metal, that the texture of the large ingots from which the sheets of sheathing are rolled is no longer so homogeneous as that of the small test ingot; they affirm also that this texture may vary greatly, according to the conditions in which the ingot is allowed to cool. It is evident, therefore, that during the processes of hot and cold rolling, and of annealing, to which the alloy is subsequently subjected, its texture may undergo various changes; while it is certain that the comparative durability of the sheathing, when exposed to the action of sea-water, must in great measure depend upon its relative compactness. If it be open and porous, as would be the case if a trace of the fibrous structure were present, it is clear that the sheathing would soon be destroyed;—not only because the salt water would come in contact with its interior portions, but also since the individual crystalline fibres of the alloy would doubtless resist its action more completely than the amorphous matter attached to them or contained in their interstices; from this a voltaic action would be produced, which could not fail to promote the corrosion of the alloy."

(*To be concluded.*)

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II. GEOLOGY.

1. *On Prof. J. W. Dawson's papers on the Coal.*—Prof. J. W. DAWSON, LL. D., of McGill College, Canada West, has lately published in the Proceedings of the Geological Society of London two very interesting memoirs:—one concerning the vegetable structure in coal;* the other on a terrestrial mollusk, a *Myriapod* and some new species of reptiles from the coal of Nova Scotia.

The formation of the coal and the composition of its combustible matter may be considered as settled questions. But we are still far from being well acquainted with the true nature of the coal plants, and with their generic and specific affinities. Fossil plants are found preserved in two different ways. In the shales and the sandstones the outline of the vegetable is marked just as it would be on the stone by the pencil of a lithographer; but no trace of internal structure is preserved; and as these remains are mostly broken parts of stems and of leaves, crushed cones, scales or blades, nutlets and prints of various forms left on the bark of some trees at the point of attachment of the leaves, it is nearly impossible to determine with precision the species to which such fragments belong, or at least to get any indication about their mode of vegetation and their relation to plants now living.

In the coal on the contrary we find a few remains of internal organism, chiefly vessels of various appearances. But in the compact, homogeneous matter of the coal, every trace of external structure of the plants having disappeared, these isolated vessels can not, in any way, indicate the form of the plant to which they belong.

It is especially in treating the laminæ of mineral charcoal intermixed with compact coal by chemical maceration, that Prof. Dawson has been able to separate the vegetable fibre and to study the form of some of the vessels. The result of these researches is satisfactory to this point; it proves by a direct experiment that the coal is a compound of different species of plants. Though many palæontologists had already come to the same conclusions by researches of the same kind, Prof. Dawson is the first who has succeeded in clearing the woody fibre perfectly from every particle of amorphous substance, and thus his assertions are more conclusive and more reliable. Nevertheless, some of these assertions are open to critical discussion.

The first question which the author proposes to elucidate by his researches (the one which relates to the precise genera and species of plants which have contributed the vegetable matter required for the coal) is perfectly well answered by himself in a note from a former paper where he says: *I have little confidence in the establishment of genera or species, on the minute structure of fragments of wood.* Of course if fragments of fossil wood can not indicate genera and species by their internal organization, *à fortiori*, neither can isolated vessels do it. The second question concerning *the causes which have produced the different qualities of coaly matter observable in the different parts of the same bed, or in different beds in the same coal-fields*, does not appear to be satisfactorily answered. Suppose we admit Liebig's theory, that coal results from the submersion of vegetable fibre:—then since the thin laminæ of mineral charcoal,

* Vol. xv, 626.

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generally no thicker than the $\frac{1}{30}$th part of an inch, alternate sometimes with equally thin layers or laminæ of compact coal, the question arises how could such thin layers be exposed to atmospheric influence while the intermediate laminæ were transformed to solid coal by immersion? The supposition *that the mineral charcoal represents the woody fibre of trees subjected to atmospheric decay, while the bark of those trees appears as compact coal along with such woody and herbaceous matter as might be imbedded before decay had time to take place*, is contradicted by numerous observed facts. In the coal-fields of the United States the layers of charcoal most frequently show prints, easily identified, of the species predominant in the shales overlaying the coal. Thus one bed (No. 1B Coal) has, especially in its charcoal, blades of *Lepidostrobus* and leaves of *Lepidodendron*. Others have in abundance the prints of the bark of *Calamites*, *Lepidodendron*, *Stigmaria* and even *ferns*.

The question whether *Stigmaria ficoides* be the root of a *Sigillaria* is far from being settled, and though the assertion that *Stigmaria* is found in every bed of fire clay is true, the deduction drawn from this fact, on the assertion of some authors—that *Stigmaria* is not found in the coal or in the shales overlaying it is without any foundation whatever. Some beds of coal have been formed by *Stigmaria* only. Whole strata of black laminated roof-shales contain only remains of *Stigmaria*.

Neither the form or the size of the scalariform vessels can be admitted as a generic character; the form of the perforations varies on the same vessel passing from round to oval, to equilateral and to true scalariform shape by gradual and inappreciable transitions. The size of the vessels varies according to the size of the same plant.

One of the most interesting conclusions reached by Prof. Dawson is that the small cylindrical filaments, resembling black threads, so abundant in the coal and mineral charcoal are composed of *bundles* of scalariform vessels inclosed in a sheaf of woody fibres. This is, says the author, precisely the structure of the vascular bundles of the petioles of ferns. It is certain that the writer has seen these filaments generally in connection with crushed stems, especially with crushed *Calamites*.

The vessels figured 8 to 12 of pl. 18, apparently belong to some species of *Stigmaria*, especially to *S. ficoides* (compare Corda's *Beytrage*, tab. 13). That tissue of this kind constitutes by far the largest part of the mineral charcoal is a proof of my assertion, that *Stigmaria* enters largely into the formation of the coal.

It is scarcely possible now to refer the genus *Sigillaria* to *Cycadea* or to the *Coniferæ*. Neither the internal structure nor what we know of the external forms of species of this genus, the leaves, the fruits, &c., can show such an analogy.

Prof. Dawson can not with certainty affirm the presence of tissue of true Conifers in the coal. This agrees perfectly with the result of ten years of explorations by the writer in the coal measures of the United States and its flora, where no trace of a true Coniferous plant has thus far been found.

The writer does not think that the coal measures of Nova Scotia give a true exhibition of the general formation of the coal. The coalfields of that country bear testimony to such continual disturbance by the repeated movements of the surface, repeated overflows, sudden invasions of littoral

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debris, sand, pebbles, &c., that any general conclusion founded on the study of such geological phenomena, would be contradicted by what we see in the distribution of the coal strata in the coalfields of the United States, at least in those west of the Appalachian mountains.

The general conclusions of this paper, appear to be perfectly just, though not necessarily derived from the microscopical researches of Prof. Dawson. But, if this assertion of the author is true; that the *sigillariæ especially, have contributed to the vegetable matter of the coal;* what becomes of the former conclusion: that the filaments so abundantly found in the coal and mineral charcoal are bundles of fibrous vessels of petioles of ferns. Moreover we must deny the prevalence of *Calamites* and *Sigillariæ* in the roof shales, at least, in the coalfields of the United States. Each bed of coal, according to its age, or geological horizon, has some plants peculiar to itself predominating in the shales, and the same plants are found, apparently in the same proportion, in the whole thickness of the coal.

In his second paper,* Prof. Dawson most satisfactorily confirms a former discovery made by himself and Sir Charles Lyell, of the presence of terrestrial animals in the coal measures of Nova Scotia. In like circumstances, viz., in the hollow petrified trunk of a standing tree, he has found numerous well-preserved specimens of the same land shell, *Pupa vetusta* Daw., before discovered at the same locality; some remains of a new genus and species of an articulated animal, resembling a Myriapod, *Xylobius Sigillariæ* Daw.; and portions of two skeletons of animals belonging to a new *reptilian* genus, *Hylonomus* Daw., two species of which *H. Lyellii* Daw., and *H. aciedentatus* Daw., are figured and described in the paper.

Every geologist will recognize the great importance of this discovery, as respects both palæontology and the history of the coal formations. This history is slowly unfolding itself by the unwearied researches of a few true lovers of science, who like Prof. Dawson, endeavor to compensate the want of coöperation in such a thankless field of science as that of fossil botany, by incessant and conscientious labor. Discoveries of nearly the same kind as those of Prof. Dawson, have been made lately both in Europe, and in the United States. Goldenberg has found in the coal measures of the Vosges, in France, new species of *Blattinæ*, *Thermites*, *Dyctioneuron*, &c., and five wings of a *Blattina* have been lately found in the lowest coal of Arkansas. L.

2. *Thirteenth Annual Report of the Regents of the University of the State of New York*, (for 1859), 128 pp. 8vo. Albany, N. Y.—The cover and title page of this Report bear the date of 1860, with the addition, "made to the Senate, April 10, 1860." It contains in addition to the usual annual statement of the business affairs of the State Cabinet, six Appendises. Of these, A, B, C and D are catalogues of various collections and donations. The Appendix, E, is an interesting paper entitled "Ancient Monuments in Western New York, comprising the results of explorations by T. Apoleon Cheney, Civil Engineer, etc., 1859." It is illustrated by 24 plates and a map of various mounds, excavations and antiquities of the aboriginal inhabitants of the country.

Appendix (F) has a separate title page thus: "Contributions to Palæontology, 1858 and 1859. By James Hall, *Geologist* and *Palæontologist*, etc." We are thus particular in noticing these dates because

* Quart. Jour. Geol. Soc. London, xvi, 268, 1860.

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we have been informed that Prof. Hall has introduced into this paper under new names several species which have been described by other authors during the year 1860. Should this Appendix be separated from the Report and circulated with no other information as to the date than what is given on the title page, palæontologists in other countries may possibly be led to quote its contents with a date as far back as 1858.* From what appears upon the cover of the Report itself most people would suppose the date of publication to be April 10, 1860. Such however is not the fact. We have ascertained that "the first lot of (this) Regents' Report was delivered (by the Printer) Dec. 17, 1860, to the Regents of the University," (letter from C. Van Benthuysen, the printer). We have evidence that important changes were introduced into the text of the Geological part as late nearly as the above date, if not even later. Such additions should have been indicated by an appropriate date either in the text or on the cover of the Report. We regret extremely to feel compelled to make this statement. But having been long aware that similar changes had been made in the 12th Report, after it had been in part circulated and noticed in this Journal (xxviii, 149), we cannot permit this recurrence of the same practice to pass without our earnest protest. We would therefore respectfully suggest to the Regents that hereafter they should take every precaution to prevent this confusion of dates in the publications that issue under their authority. The interests of science demand that all misunderstandings between naturalists should be guarded against, and nothing can be more likely to make a man of science feel that he has been unfairly dealt with than to see another obtaining priority over him by fictitious or indefinite dates. Another Regents' Report will be due either in the present month of March or perhaps in April. Let it be printed and circulated *as presented* at once, or if it be delayed to accommodate authors, let the date of actual *publication* be given as well as the date of presentation to the Senate.†

Prof. Hall's paper contains notices of about one hundred (mostly new) species of fossils from the Silurian and Devonian rocks of the United States. He proposes the following new genera of Brachiopoda:

1. Skenidium.—This genus if adopted will include several species heretofore referred to *Orthis;* the dorsal valve flat and the ventral valve of a pyramidal shape.

2. Amboccelia.—The types of this group are said to be *Orthis umbonata*, Conrad, and *Spirifer unguiculus*, Sowerby. It is therefore the same as McCoy's genus Martinia. (See McCoy's British Palæozoic Fossils, p. 377.)

3. Vitulina.—The species resemble *Orthis* with the dorsal valve flat,—the ventral valve pyramidal,—ribs large.

4. Leiorhyncus.—Shells with the general form of *Rhynconella* but with the "plications more rounded, and rarely or never continued to the lateral margins

* In confirmation of this suggestion we have received (January 19,) a brochure from the author entitled: "*Contributions to Palæontology*, 1858 *and* 1859 *By James Hall, Geologist and Palæontologist, etc.* (From the Thirteenth Annual Report of the Regents on the State Cabinet,) pp. 55–128, 8vo." On the cover there is the same title but the date there reads, "1858 *and* 1859 *with additions in* 1860." This is still too indefinite.

† No principle is more thoroughly established in the ethics of science than that the date of *publication* and not the date of *composition* or *printing*, settles the question of priority of authorship. Hence has arisen the practice of Authors of distributing separate copies of Memoirs in advance of publication of an official report—thus securing the earliest practicable date of *publication*. To this course no objection can be made, but no changes from the original text are admissible.

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which are more compressed than in *Rhynconella* proper. The internal structure appears, so far as ascertained, to be the same as in *Meristella*" = (*Athyris pars*)?

5. MERISTELLA.—Intended to include that group of species of *Athyris* (McCoy) which has *A. tumida* Dalman, for the type. It is not probable that this proposal will be accepted because, if McCoy's genus is to be divided, then we have three names (long in use) to be accommodated, that is to say, *Athyris*, *Spirigera* and *Merista*. No new names can be admitted until all the old ones shall have been provided for.

Athyris, must be retained for the group with the beak of the ventral valve imperforate and closely incurved and with the mesial septum in the dorsal valve. (Type *A. tumida*.)

Spirigera, must include those with the beak of the ventral valve perforated and a rudimentary mesial septum in the dorsal valve. (Type *S. concentrica*.)

These two genera are limited as above by DAVIDSON in his "Introduction to the Classification of the Brachiopoda," pp. 84–87: and by F. ROEMER in the last edition of Bronn's "Lethaea Geognostica," vol. i, Pt. 2, p. 330–331. It is quite clear that if *Meristella* be retained then either *Athyris* or *Spirigera* must be suppressed in order to make a vacancy for it. There is no probability of this being agreed to by palæontologists. The other genus *Merista* will no doubt hold good for those species which have the shoe-lifter process in the ventral valve.

Prof. Hall describes a new genus of Crinoids under the name of *Cheirocrinus*, and also proposes two new genera of trilobites *Barrandia* and *Bathynotus* to include the peculiar forms from Vermont heretofore referred by him to the genus *Olenus*. It has perhaps escaped Mr. Hall's notice that McCoy has published a trilobite genus "*Barrandia*" in the "British Palæozoic Fossils," p. 149. McCoy's genus appears to be disputed but still it must be retained until it is clearly shown to be without foundation.

3. *Geological Surveys.*—TENNESSEE. Prof. Safford is now publishing the first volume of his Report on this State. It will be in two parts. 1st. The Physical Geography of Tennessee, 2d. The Geological Structure and the Formations of Tennessee. It is in 8vo, and will contain a map of the State and 20 or 30 plates, chiefly fossils. Its completion is expected in about three months. A *second volume* to be published hereafter, will contain Part 3d, the Minerals and mineral resources of the State, and Part 4th, the Agricultural resources.

KENTUCKY.—The publication of the fourth and concluding volume of this Survey is in the hands of Dr. Robert Peter, of Lexington, Ky. The matter will form a large and very valuable volume. The Legislature ordered 7000 copies to be printed. The completion of the work may be expected during the coming summer, if political causes do not arrest the progress of the work.

TEXAS.—We learn with regret that the removal of Dr. Shumard (noticed on p. 124) was caused solely by political considerations—his successor being an "Old Texian," which Dr. Shumard was not! An intimation that influential scientific names had been used to effect this change appears to have no foundation in fact, and was probably intended only to justify so remarkable a step. The effect of the change will probably be to abolish the work at the next session of the Legislature.

4. *Trilobites of the Wisconsin 'Potsdam.'*—Upon examination of the "small trilobites" from the Potsdam sandstone from "Black River Falls," Wisconsin, presented to the Boston Society of Natural History by Prof. Daniels, as mentioned on page 310 of vol. vi of the Society's Proceedings, they are found to be identical with the *Conocephalites minutus* from Keeseville, N. Y. Accompanying them are fragments of two or three

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other small small trilobites too indistinct for absolute determination; one seems to be nearly allied to the genus *Bathyurus* (Billings). The specimens also contain a *Theca*, apparently *T. triangularis* (Hall); as also a few *Lingulæ*, which, while they *may* be *L. prima* of New York, yet vary so much that their identity seems hardly possible. J. H. BRADLEY.

5. *Chrome Garnet.*—I have recently discovered a beautiful emerald green garnet in Oxford, Canada, in calcareous spar with millerite. It is massive, granular, or in transparent dodecahedrons and resembles ouvarovite, but is essentially a lime-alumina garnet with 6·0 p. c. of oxyd of chromium. I shall soon send you a full description with an analysis.

Montreal, Jan. 21st, 1861. T. S. HUNT.

III. ZOOLOGY.

1. *Contributions to the Natural History of the United States;* by Louis Agassiz. Vol. III.—*Acalephs in general—Ctenophoræ.* Nothing goes farther to prove the necessity of a wide and far-reaching study of animate nature than the facts brought to light by the examination of jelly-fishes. It is the misfortune of most zoological text-books, and of popular science in general, that such stress is laid on the structure of Vertebrata, so many illustrations drawn from them, and so much emphasis given to them, as the head and type of the animal kingdom, and the scale by which all other animals are to be measured, that the student gets to look on everything else as something intrinsically inferior in character and uncertain in position.

This wrong idea is well illustrated by the expression Vertebrates and Invertebrates, as if the first were a division equal to, and co-extensive with, the second. Invertebrates are a common refuge for all creatures so unfortunate as to have no back-bone; just as Infusoria furnish a convenient reservoir, into which to pour all small objects that cannot easily be seen. Again, naturalists are led, by such partial studies to make many false generalizations; such as, that the rapidity and force of motion are in direct ratio to the size of the nervous centres and to the perfection of the muscular system; whereas we see such medusæ as *Coryne* (*Sarsia*) and *Pleurobrachia* executing swift and complicated motions, though they have neither nervous nor muscular systems, properly so-called. Then the incorrect homologies that are attempted: the comparison of the head-ganglion of a cephalopod to the brain of a mammal; the structure of a worm to that of *Petromyzon;* and of the limbs of an insect to the limbs of the higher vertebrates. To this may be added the false ideas of rank among the different groups; placing the whole of the Articulata below Vertebrata; the whole of the Mollusca below Articulata, and the whole of the Radiata below Mollusca. Whereas no such comparisons can be made between the different plans of creation, and no such systematic subordination established. The squids, among Mollusca, so far as they can be compared, stand certainly as high as any of the crabs, and possibly higher than the lamprey eels. The radiate *Spatangus* is, without doubt, a more complex mechanism than the molluscoid *Vorticella*, or the articulate *Rotifera*.

Books like this third volume of "Contributions" will do much to give to the mass of scientific men, those broad and philosophical views, which are now almost confined to the leaders. We here have revealed to us, in all its richness, a class which includes in its apparently humble

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limits some of the most extraordinary phenomena of generation, of growth and of life.

The first chapter treats briefly of the history of our knowledge in this branch, from the time of Aristotle, (who confounded sea-anemones and jelly-fishes under the common term *nettles*), down, through many barren centuries, to near our own day, when Rondelet, three hundred years ago, published figures of medusæ, with some observations of his own. Two centuries more added comparatively little to the store of information; O. F. Müller, however, had published the *Zoölogia Danica*, the colored plates of which are fitting forerunners of the magnificent drawings of Lesueur, illustrating the numerous acalephæ, collected by him and his companion, Peron. The *System der Acalephen* by Eschscholtz, which not only embodied all heretofore known, but was further enriched by the material accumulated during two voyages round the world, served to show the great number and variety of these animals. The important exploring expedition of Quoy and Gaimard in the Physicienne and the Astrolabe; of Prof. Dana, in the expedition under Capt. Wilkes; and of Fitzroy in the Beagle, have done much to complete the necessary specific knowledge.

The first discoveries of Sars in the embryology of medusæ are striking illustrations not only of the gradual way in which zoölogical truths are arrived at, but also of the mistakes which come from a partial knowledge of any animal. They show that we cannot judge the embryo from the adult, or the adult from the embryo; and, what is yet more important, they exemplify the fundamental fact, that the embryo of a superior class resembles the perfect creature of an inferior class, in the same type. It was in 1829, that the Norwegian naturalist described a new genus of polyps under the name of *Scyphistoma*, and another peculiar one, of medusæ called *Strobila*. In 1841, through his own discoveries and those of other naturalists, he was enabled to prove, 1st, that *Scyphistoma* was the first stage of *Strobila;* 2nd, that *Strobila* was the fixed stock, which by transverse division, produced individuals of the genus *Ephyra;* 3rd, that a species of *Ephyra* was the young of *Aurelia aurita;* and 4th, that the eggs of *Aurelia aurita* produced a species of *Scyphistoma;* the two ends of the line of growth were thus joined and the cycle of the species perfected. In this way were the foundations laid for a general embryology of the covered-eyed medusæ. The connection between the so-called hydroid polyps and the naked-eyed medusæ, was yet to be shown. In 1843, Dujardin supplied the wanting link, by discovering that the medusa *Cladonema* was the offspring of the hydroid genus *Syncoryne*. The other two orders, Ctenophoræ and Siphonophoræ, do not present embryological difficulties of the same sort; the first named have young resembling the parent, though with shorter rows of flappers; somewhat as spiders, among insects, have no proper larval condition, but gain another pair of legs on coming to maturity.

It would be natural to challenge the standing of a class, containing such seemingly heterogeneous groups. What have they in common? Not a common embryology:—not a common detail of structure:—least of all a common *form*. Here then we are compelled to resort, to what we should daily resort to, without compulsion, the *metaphysics* of zoölogy. If we agree to call that a class which shows a plan of structure carried out in a peculiar way; then two questions come up: 1st, what is the peculiar way in which the general plan of radiation is carried out among

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the Acalephs? and 2d, do all the so-called Acalephs really agree in the way in which the plan of radiation is through them exemplified? The peculiar model, so to speak, of a jelly-fish may best be seen by contrasting it with a polyp; for instance an *Actinia*;—and first it is plain that the jelly-fish carries the so-called stomach of the polyp turned *inside out*, and forming the proboscis (compare *Rhizostoma*, *Cyanea*, &c.); even where there is no proper proboscis, the stomach is not inverted into the body (*Bolina*, &c.). What is commonly spoken of as the stomach of a medusa is nothing more than the visceral cavity, into which open the radiating tubes, just as the free chambers of the polyp open into its visceral cavity. The jelly-fish has however a circular tube, running round the edge of the disc, and making a common receptacle for all the radiating tubes; a feature not found in the polyps. Then the fleshy interambulacral partitions, so thin and regular among polyps, are thickened, among medusæ, and coalesce above and below, leaving only narrow, radiating tubes through their gellatinous mass. With the model thus hastily sketched, all Acalephæ will be found to agree. The Ctenophoræ, which Quoy and Vogt would (no one can tell why) refer to Mollusca, are readily homologized. Taking *Idyia* as an instance, there is the visceral cavity, the circular marginal tube and the radiating tubes leading into it. The peculiar appearance of this particular group rises from their unusual height, their little rows of tentacles, called "flappers," and the arrangement of their parts in 8's, instead of 4's. It is in the order of Siphonophoræ that the triumph of class homologies has been the greatest;—here we are forced at once to take an embryological view, just as we are in considering the lampreys in connection with the fishes, or the marsupials, in connection with the mammals. Knowing that hydroids are one stage of true Acalephæ, and taking *Hydractinia* in comparison with any siphonophorous community, like *Velella*, we see that the polymorphous individuals may be compared in the two; *Hydractinia* is attached, *Velella* is free; the expanded base of *Hydractinia*, from which rise the different hydræ, forms in *Velella* the swimming vesicle. If further proof were needed the "tentacles" (hydræ) of *Velella* actually produce *free medusæ*. Such elongated communities as *Diphyes* may, in like way, be homologized; there are a few medusoid individuals ("swimming bells"), then hydroids ("polyps") protected by a "scale" and bearing on their proboscis male and female medusæ buds ("ovaries").

Not the least interesting addition to the hydroid medusæ is the discovery, by Prof. Agassiz, that *Millepora alcicornis*, of the Florida reefs, belongs to this division, and not to the actinoid polyps. It becomes hereby probable, that the whole of Milne Edwards' division *Tabulata*, which includes *Millepora*, *Pocillopora*, &c., is to be considered as among the Acalephs; and, further than this, his Rugosa, which include only fossil genera, are so distinct in many respects from the true stony corals, and so remind us in some genera, of the *Strobila* stage among the covered-eyed medusæ, that we are led to suspect *their* affinity also with the acalephæ. Be this last as it may, it is now pretty well established that jelly-fishes are represented, through the millepores, in some of the earliest geological formations; a point of the greatest importance in palæontology.

A proper review of Part II, on Ctenophoræ, could not be brought within the limits of this short notice. It consists of a critical analysis of Ctenophoræ in general; a consideration of their natural families; thorough

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anatomical investigations of the North American species of *Bolina*, *Pleurobrachia*, and *Idyia*; a systematic tabular view of the known Ctenophoræ; and a table of their geographical distribution. Among the most interesting of these investigations are the variations of form as dependent on the development of different "spheromeres" or radiating wedges of which the body is made up; and the remarks on the circulation of chyme.

The illustrations by Sonrel, Burkhardt, and Prof. Clark, are unrivalled in their way; Sonrel's large drawing of *Cyanea arctica* is a miracle of skill and patience. T. L.

Note.—The important chapter on individuality among acalephs is not mentioned here, because it has already appeared in this Journal, (vol. xxx, 142).

IV. ASTRONOMY.

1. *Translation of the Sûrya-Siddhânta, a Text-book of Hindu Astronomy*, (Journal of the American Oriental Society, vol. vi).—We take pleasure in bringing to the notice of our readers, and especially those who are students of astronomy, this highly important contribution to the history of that science. Ever since India began to open itself to the knowledge of the western nations, about the middle of the last century, it has been well known that the Hindus have a peculiar system of astronomy, which is neither recent in its origin nor inconsiderable in its development. The curiosity and interest which this fact could not fail to awaken, are attested by numerous works which relate, wholly or partly, to the Indian astronomy—the productions either of European savans, like Bailly, Delambre, Biot, or of Englishmen resident in India, as Davis, Colebrooke, Bentley, Warren, and many others. It is remarkable, however, that while so much has been written on the subject, no work has appeared before the present, from which the occidental scholar could find out what the Indian astronomy is,—how it exists, as a system of theory and practice, a science and an art, in the Indian mind. It is the want of any such work, which has given rise to the publication before us. Rev. Mr. Burgess, formerly missionary of the American Board of Missions, while laboring among the Marâthas of western India, was called upon to prepare an astronomical text-book for the instruction of the natives. In executing this task, he was, naturally and almost unavoidably, led to study the astronomical system of the Hindus themselves. He found, however, much to his surprise, that there was no published book, from which he could obtain, in a comprehensive and systematic form, the information which he wanted. The perception of this deficiency suggested the idea of supplying it. To facilitate for others the acquisition which cost him so much time and trouble, he determined to translate one of the *Siddhântas*, or astronomical treatises, of which there are a considerable number (for the most part, yet unpublished) in the Sanskrit language. He selected for this purpose the Sûrya-Siddhânta, which appears to be the most highly esteemed and the most generally used of these works. In preparing his translation, and in gathering matter for an explanatory commentary, he received the aid of native Pandits. He left India, indeed, without having accomplished his design; but desiring still that his work should be made available for the

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cause of science, he placed his collected materials at the disposal of the American Oriental Society. The result appears in the sixth volume of the Society's Journal, in an article of 350 pages (more than half the volume), of which a separate edition has also been struck off, and can be obtained, at $2.50 a copy, from the Society's agents (New York, John Wiley, 56 Walker st., etc.). It has been prepared by Mr. William D. Whitney, Professor of Sanskrit in Yale College, and Corresponding Secretary of the American Oriental Society. In revising the translation, he has aimed to make it, not only faithful, but also in some degree intelligible, by expanding the condensed expressions of the original, and by giving English equivalents for the scientific, technical, and mythological terms which abound in it. In the last case, however, the demands of the Sanskrit scholar are satisfied by adding the original terms enclosed in marks of parenthesis. We say, "*in some degree* intelligible"; for a mere translation, however skilfully executed, would of necessity present numerous and almost insuperable difficulties to the occidental reader. These difficulties arise, partly, from modes of conception peculiar to the Indian mind; partly, from peculiarities in the methods and processes of the Hindu arithmetic and geometry; partly, from the fact that the work is composed in Sanskrit verse,—a mixture of poetry and science which is familiar to the Hindus, though to our view incongruous and absurd. The style of the original is exceedingly condensed and cramped, and its language often vague and ambiguous. In fact, it was never intended for easy reading. It was not meant to be an open source, from which an unlearned man could draw out for himself the knowledge of astronomy; but rather a secret repository of astronomical science, accessible to the initiated, and employed by them for the uses of instruction, the teacher supplying in his own oral comments the indispensable explanation.

To remove the difficulties of which we speak, Prof. Whitney has added a copious and elaborate commentary, which follows the translated text from point to point, and not only illustrates its meaning, but compares its principles and processes with those of European astronomy. It presents the results of long and careful study in a perspicuous and attractive style, which cannot fail to interest all who are capable of taking an interest in the subject. The demonstrations which are given to show the correctness, or (as the case may be) incorrectness, of the Hindu rules and methods, are drawn out with much fullness and clearness, and offer no difficulty to those who have a fair acquaintance with the elements of geometry and trigonometry. It appears from an acknowledgment in the introduction, that Mr. H. A. Newton, Professor of Mathematics in Yale College, has rendered important assistance in the preparation of this commentary.

The subject of Eclipses is treated with particular care. This may be regarded, indeed, as the centre of Hindu astronomy, the great end of astronomical pursuits among that people being the prediction of these phenomena. Besides his remarks in illustration of the text, Prof. Whitney has given an extended calculation of the lunar eclipse of February 6, 1860, made by himself in strict conformity with the data and methods of the Sûrya-Siddhânta. We find also a calculation, according to Hindu data and methods, of the solar eclipse of May 26, 1854; this, however, was mainly prepared for Mr. Burgess by his Hindu as-

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sistant, and it illustrates, as we see from the accompanying criticisms, the negligence and looseness with which the methods of their books are applied in practice by the native astronomers.

One of the most interesting chapters is that which relates to the *nakshatras*, or lunar asterisms, a series of star-groups, twenty-eight in number, encircling the sphere, and seemingly known to the Hindus from a very early period. Prof. Whitney, in his learned and masterly discussion, compares these Indian *nakshatras* with the *sieu* of the Chinese and the *manâzil* of the Arabs. He comes to the conclusion that they did not originate in India; but he shows at the same time, that they were not brought, as Biot supposed, from China into India; if they originated in China, they must have been carried first to some country of central Asia, where they received a modified form, and thus afterward passed into India on the one hand, and into Arabia on the other, to undergo further special modifications in each of these countries.

The relations of the Indian science of astronomy to that of the Greeks are often noticed in the course of the commentary, and form the subject of a closing note, which sums up in a very clear, and, to our mind, convincing manner, the results to be drawn from the foregoing expositions. The conclusion, in brief, is this, that the Hindu science must be regarded as an off-shoot from the Greek, planted not far from the commencement of the Christian era (probably before the time of Ptolemy), and attaining its fully developed form in the course of the fifth and sixth centuries. Among the points of agreement between the two systems, the most striking is the use of epicycles for representing the motions, and calculating the positions, of the planets. This is a cardinal feature in both systems, and is essentially the same in both. There is no reason to suppose that the Greeks borrowed it from the East, but much reason for believing the contrary. To regard it as originating in India is opposed to all we know of the scientific character and tendencies of the Hindus. Acute as they are and fond of speculation, they have never shown an aptitude for the study of external nature, and could not have made the exact and long-continued observations of the stars, on which that system must have been founded; their books, indeed, contain no records of astronomical observations. The division of the circle also presents traces of a Greek origin; and the Greek names for *minute*, *hour*, *centre*, are found in the Hindu text-books. The Greeks, in fact, are, not unfrequently, referred to in the treatises of earlier date, as authorities on astronomical subjects. But the Hindus, if they borrowed the Greek astronomy, have set upon it the stamp of their own thinking; they have given it, in general, an arithmetical, instead of a geometrical, form; and have made a really valuable improvement by substituting, in their calculations, the sines of arcs for the chords which were used by the Greek mathematicians.

We must add, however, that Mr. Burgess does not accept these conclusions. In a note appended to the article, he sets forth his dissenting views, maintaining the originality of the Hindu science, and contending that the features common to the two systems were either developed independently in both countries, or were imported into Greece from the East.

The value of the work is much increased by a copious index, which furnishes to those who may not care to study it as a whole, the means of finding readily all that it contains on any particular topic.

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V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Interesting discoveries of Saurian and other fossil remains in the Red Sandstone of E. Pennsylvania, in a letter from* C. M. WHEATLEY, Esq., of Phœnixville, Pa., to one of the Editors.—I have within the last three months made some important discoveries in our black shales of the Phœnixville Tunnel. I have found a true "*Bone Bed*" and have obtained from it *Saurian Bones* of very great interest, whether *Clupeisaurus* Lea, *Centemodon* Lea, or *Omosaurus* Leidy, is difficult to determine. These fossils are on masses of rock, too large for removal; they comprise *vertebra*, *ribs*, *tibia*, *femur*, *coracoid*, and other bones. I will describe the bones on the masses of rocks as I obtained them, viz.:

On No. 1. Concave vertebra 2½ *inches* in diameter with spinous process 6 inches long from centre of vertebra, and other bones.

On No. 2. Part of a very large bone 3½ inches long measuring across largest end 2½ in. and at smallest 2 in. with ribs, vertebra, and other bones.

On No. 3. Fine large bone 7 inches long, 2 in. diameter at smallest end, 3½ inches over condyles. This bone has a *large medullary cavity*. Another bone on same rock is 10½ inches long, diameter at smallest end 1½ inches: a coracoid on same stone, with other parts. Other pieces exhibit ribs, vertebra, spinous process, teeth, coprolites, some with scales and bones of Ganoid fishes in them.

Equisetum calumnare? very fine specimens 15 to 16 inches in circumference and 7 in. long, the first time it has been noticed this side of Richmond (Va.) Coal Basin.

Pterozamites longifolius like those figured in Emmons's North Carolina Report. *Gymnocaulus alternatus* Em. *Fir Cones*, 3 in. long, 1 inch wide, two species of *Estheria*, *Cypris*, *Myacites*, *Pennsylvanicus* Conrad, and a lot of undetermined fossils—some very like *Crustaceans* and *possibly* remains of *Insects*.

2. *Upheaval of the sea and inundation at Kahului and Maliko, Maui, Sandwich Islands.*—A sudden tide wave occurred on the 2d of December, 1860, along the coast of East Maui, lying between Kalului and Maliko, and extending farther on toward the Hana district, a distance along the shore of some twenty-five miles. The wave, of which there was but one on this occasion, rose about eight feet, and resembled the same phenomenon which occurred in that district some twelve or fifteen years ago, and which consisted of several waves, following each other at short intervals. It took place during the night, and created some consternation among the natives. No serious damage was done, though two or three native huts at Maliko are reported as having been removed from their foundations, and a wharf or staging erected by the new sugar company at the same harbor were carried inland and left high and dry, when the water receded. These phenomena are no doubt caused by the volcano of Mauna Loa, which by a submarine eruption creates a disturbance in the sea.—*Pacific Advertiser, Honolulu, Dec.* 12, 1860.

We look with interest to the tidal register of the Coast Survey to learn whether this vibration was felt along the Pacific Coast of this Continent as in the more remarkable case of the great upheaval at Jeddo in 1854.

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3. *Dr. Cooper's reply to Gov. Stevens's charge of Plagiarism in* vol. xxx, p. 302.—We have received a long letter from Dr. Cooper dated at San Francisco, Nov. 20, 1860, in which he reviews the charges of Gov. Stevens with more detail than the public interest in the controversy warrants, or than our space can admit.

Dr. Cooper's manly explanation of the origin of Gov. Stevens's complaints which we give below, and the laudable spirit which characterizes his communication, at once relieves this gentleman from any suspicion of intentional injustice to Gov. Stevens, and renders the publication of other details needless.

Dr. Cooper states that he assisted Gov. Stevens largely in the preparation of the Chapter on Meteorology. While he disclaims any intention of appropriating any of Gov. Stevens's labors, he adds that "nothing but the accident of his arriving at Washington (in July 1859) after the work was printed, had prevented his giving credit to Gov. S. for the authorship of the Chapter on Meteorology."

"I have offered," says Dr. Cooper, "to Gov. Stevens, in a letter, (which he did not wait to receive before publishing his reclamation for my 'plagiarism,') to go the expense of an extra title page to the Chapter on Meteorology, without mention of my own name. This can be sent to each owner of a copy to be pasted in before the Chapter, and will give credit more conspicuously, than if his name was in the general title page of the book."

"I have offered to consider any plan which he may esteem preferable."

As Dr. Cooper also proposes, "to refer to the Editors of this Journal the question of the propriety of his making farther acknowledgments or concessions"—we have only to say, while we believe that Gov. Stevens will be satisfied with the disclaimers and explanations of Drs. Cooper and Suckley, we cannot doubt that it would have been more satisfactory to all parties had the general title page of the "Contributions to the Natural History of Washington Territory," stated in substance "that these observations were made in connection with the Expedition to survey routes for a Pacific Railroad from the Mississippi River to the Pacific Ocean near the 47th and 49th parallels of N. latitude, under command of Gov. I. I. Stevens."

4. *Fulgurites or Lightning tubes.*—Dr. Hitchcock informs us (Nov. 20, 1860) that he has received from Dr. A. Cobb, of Montague, Mass., "specimens, which appeared to be some kind of slag, more or less tubular, with the cavities glazed on the inside and rough on the outside; looking externally somewhat like branched coral; the branches nearly an inch in diameter and flattened. In short, it was obviously fine sand which had been fused by heat on the inside of the mass, so as to form a thin pellicle of brown glass. The specimens were found at Northfield Farms, in Massachusetts, on what was supposed to be an old Indian camping ground, or battle-ground." They are obviously fulgurites.

5. *New Meteorites from Hindostan.*—Two meteoric stones fell on the 28th of Feb., 1857, near the village of Parnallee in Southern Hindostan, about noon from a cloudless sky—one of them weighing about 37 pounds, has reached this country as a gift from Rev. H. S. Taylor, to whom we owe the history of the fall, to the Cabinet of Western Reserve College, Ohio. A description of this stone will appear in our next.

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6. *Results of a Scientific Mission to India and High Asia* 1854 *to* 1858, *by Hermann, Adolphe and Robert de Schlagintweit.*—We have received the Index to vol. i. of this important work, together with four large maps, of which No. 1 shows the routes taken by the Brothers Schlagintweit through India and High Asia; No. 2 shows the lines of equal magnetic declination; No. 3 the lines of equal magnetic dip; and No. 4 the lines of equal magnetic intensity throughout India as far north as lat. 40°. This work is published in quarto in the best style by Brockhaus of Leipsic, and forms an important contribution to our knowledge of terrestrial magnetism. When the entire work has been received we propose to give a full account of its contents. The maps are very perfect specimens of cartography and chromatic printing.

7. "*The Botanical Society of Canada,*" an institution of great promise, was established at Kingston, Canada West, on the 7th of December last, at a meeting called for the purpose at Queen's College, the Rev. Principal Leitch in the chair. Principal Leitch is the President of the Society, and Prof. George Lawson, Secretary. We have read with great interest the report of one or two meetings of this Society, at which valuable papers were read, and we learn that arrangements are made for the publication of the botanical papers of permanent interest which are read before the Society.

8. *Assinniboine and Saskatchewan Exploring Expedition.*—Prof. Hind's interesting narrative of his explorations in this region (see vol. xxx, p. 288,) is about to be published by Longmans in London, in an 8vo, the neatly reduced maps for which edition have reached us.

9. *The American Association for the Advancement of Science.*—This body adjourned to meet at Nashville, Tennessee in April next. The Local Committee had fixed on the 17th of April, the third Wednesday, as the day of meeting. We learn however that there is a possibility the Standing Committee, who have charge of the affairs of the Association *ad interim*, acting with the Permanent Secretary, will advise a postponement of this meeting for one year, owing to the disturbed condition of public affairs.

Obituary.

10. Major John LeConte.—This well known naturalist died at Philadelphia, on the 21st of November, 1860, aged 77, having been born at Shrewsbury. N. J., Feb. 22, 1784. He entered the corps of U. S. Engineers in 1818, and derived his title of Major from that service. His chief contributions to science have been in botany and zoology. Dr. Coates has been requested to preface a notice of his life for the Am. Phil. Society.

11. Charles W. Hackley, Professor of Mathematics and Astronomy, in Columbia College, died in New York, Jan. 11, 1861, of a nervous fever. He was born in Herkimer Co., N. Y., in 1809, entered the U. S. Military Academy at West Point in 1825, and was Assistant Prof. of Mathematics there from 1829 to 1832. Leaving military life he studied theology and entered Episcopal orders in 1835. He was Professor of Mathematics in the University of New York from 1833 to 1839, when he was elected to the Presidency of Jefferson College, in Mississippi. From the year 1843 up to the time of his death he filled the chair of Mathematics in Columbia College, N. Y. He was the author of several elementary scientific works —a "Treatise on Algebra," published in 1846, an "Elementary Course

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on Geometry," which appeared in 1847, and "Elements of Trigonometry, with their Practical Application to Navigation and Nautical Astronomy."

Book Notices.—

12. *Illustrated Catalogue of Philosophical Apparatus;* by Edward S. Ritchie, No. 313 Washington st., Boston, 1860, pp. 84, 8vo. Also *Ritchie's Catalogue of School Apparatus.*—Mr. Ritchie's catalogues attest the neatness, skill and good taste with which his apparatus is prepared. The Illustrated Catalogue enumerates many pieces of physical apparatus not heretofore included in the catalogue of American instrument makers. Teachers will be agreeably surprised by an examination of the Catalogue of School Apparatus to find how much may be done for a very modest sum in illustrating the principles of physics.

13. *Education: intellectual, moral, physical;* by Herbert Spencer, Author of "Social States," etc., etc. New York, D. Appleton & Co., 1861. 8vo, pp. 283.—We have examined this book sufficiently to be able to say that the style of it is vigorous and the matter condensed without the sacrifice of clearness. It is composed of four essays, bearing the following titles: I. What knowledge is most worth? II. Intellectual Education. III. Moral Education. IV. Physical Education. These were originally published in the English Reviews. The discussions are able and suggestive; and will, in one particular at least, be likely to gratify the students of nature, inasmuch as they warmly insist on the superior advantages of science over languages, in the culture of youth. The author belongs to the school of Compte, and the deficiencies of his treatise, especially under the topic of moral training, are to be ascribed to this circumstance. On the whole, however, while the attention of the reader is strongly drawn to the profound importance of the general subject of education, the views taken in the book are commonly well sustained.

We observe also that it is proposed to issue by subscription, Mr. Spencer's System of Philosophy, comprising First Principles, 1 vol. The Principles of Biology, 2 vols. The Principles of Psychology, 2 vols. The Principles of Sociology, 3 vols. The Principles of Morality, 2 vols. Messrs. D. Appleton & Co., 443 and 445 Broadway, N. Y., are the American publishers.

VI. BOOKS RECEIVED.

The Report of the British Association, Aberdeen, 1859. (From the Association.) London, 1860. 8vo, pp. 310 and 312.

Magnetical and Meteorological Observations. St. Helena. Vol. II. 1844-49. Printed by the British Government under the superintendence of Maj. Gen. Edward Sabine. London: Longmans. 4to, pp. 526. Presented by the British Government.

Occasional papers on the Theory of Glaciers by James D. Forbes, D.C.L., F.R.S. Edinburgh: Black. 1859. 8vo, pp. 278.

Siluria: The history of the Oldest Fossiliferous Rocks, &c., by Sir Roderick Impey Murchison, &c., &c. Third edition (including "*The Silurian System.*") London: John Murray. 1859. 8vo, pp. 592, 41 plates. [The two last valuable works by the carelessness of a forwarding agent reached us *two years* after date.]

Thirteenth Annual Report of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History. Made to the Senate, April 10, 1860. Albany, 1860. (See notice on p. 292.)

The Manufacture of Vinegar, its Theory and Practice with especial reference to the Quick Process; by C. M. Wetherill, Ph.D., M.D. Philadelphia: Lindsay & Blakiston. 1860. 12mo, pp. 300. (A review prepared for this No. will appear in our next.)

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Manual of Geology: designed for the use of Colleges and Academies; by EBENEZER EMMONS. Illustrated by numerous engravings. Philadelphia: Sawyer, Barnes & Co. 1860. 12mo, pp. 290.

Patent Office Report (Agriculture), 1859. 8vo, pp. 589. Washington.

Coal, Petroleum, and other Distilled Oils; by ABRAHAM GESSNER, M.D., F.G.S. 8vo, pp. 134. Baillière Brothers, N. Y. 1861. (See notice in No. 91, p. 147.)

Geological Report of the Country along the line of the Southwestern Branch of the Pacific Railroad in Missouri; by G. C. SWALLOW, State Geologist. St. Louis, 1859. 8vo, pp. 93.

History, Theory, and Practice of the Electric Telegraph; by GEO. B. PRESCOTT. Boston: Ticknor & Fields. 1860. 12mo, pp. 468.

Annual Report of the Board of Regents of the SMITHSONIAN INSTITUTION, showing the operations, &c., for 1859. Washington, 1860. 8vo, pp. 450.

Warren's Descriptive Geometry, Orthographic Projections; by EDWARD WARREN, C. E. New York: John Wiley. 1860. 8vo, pp. 412. (See notice in No. 91, p. 148.)

JAHRESBERICHT der Chemie Physik, Mineralogie und Geologie für 1859. Giessen, 1860. 8vo, pp. 903.

Geological Survey of Canada. Reports of Progress for the year 1858. Montreal, 1859. 8vo, pp. 263. (See notice in No. 91, p. 122.)

Geological Survey of New York. Palæontology: Vol. III. Containing Descriptions and Figures of the Organic Remains of the Lower Helderberg Group and Oriskany Sandstone, 1855–1859. By JAMES HALL. Part I: Text. Albany: printed by C. Van Benthuysen. 1859. 4to, pp. 532.

Memoirs of the Literary and Philosophical Society of Manchester. Vol. XV. (*Second Series.*) London: H. Baillière. 1860. 8vo, pp. 316.

Philosophical Transactions of the Royal Society of London, 1850 to 1859 inclusive. 4to. From the Royal Society.

New American Cyclopedia: a Popular Dictionary of General Knowledge. Appleton & Co., N. Y. Vol. XI. 8vo, pp. 788. MAC—MOX.

NICKLÈS, J.—Les Electro-aimants et l'adhérence magnétique. 8vo, 5 planches. *Elacroix.* 2 copies.

Il Nuovo Cimento, Giornale di Fisica, Chimica, E Storea Naturale; Direttori MATTEUCCI, PIRIA, MENEGHINI. Tomo IX, X, XI. Torino, Pisa. 1859–1860.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXVII.—*The Aurora, viewed as an Electric Discharge between the Magnetic Poles of the Earth, modified by the Earth's Magnetism;* by BENJAMIN V. MARSH. With two plates.

IT was shown by Dalton that the appearances presented by the Aurora could be explained by supposing the existence of *horizontal bands* of luminous matter nearly at right angles to the magnetic meridian, and of *columns parallel to the dipping needle*, —the former constituting the auroral "arch," and the latter the "streamers"—and he suspected that the streamers either stood upon the arch, or depended from it.

Subsequent observations have confirmed the reality of these bands and columns, and have shown that, ordinarily, *the streamers stand upon the arch as a base.* When the arch is nearly overhead we see the streamers through it, as through a curtain, and have no means of determining which is the more distant, both being in the same direction from the eye. But when, as more frequently happens, the whole display lies far to the north of us we can observe clearly the relative position of the parts. We then see an arch stretching over the northern horizon, with streamers standing upon the arch and not extending below it. The tops of the streamers may be at very unequal elevations but their bases will generally be found arranged in the regular curve of the arch—although when there are two concentric arches the streamers from the lower may appear to extend into the upper and thus render the phenomenon more complicated.

The auroral arch as seen over the northern horizon is generally a perfect and regular arc of a circle, its highest point being

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nearly on the magnetic meridian and its extremities resting upon the horizon. This being true in all longitudes where observations have been made, it necessarily follows that the arch is always part of a circle, the centre (or rather the pole) of which corresponds very nearly to the magnetic pole of the earth.

In the great display of August 28th, 1859, the arches seemed to centre in the northeast as seen from California, nearly in the north from Philadelphia, and in the northwest as seen from England. So that there is great reason to suppose they were *rings, more or less perfect surrounding the north magnetic pole, and parallel to the surface of the earth beneath them.*

In the Journal of the Franklin Institute for November, 1859, I gave what appeared to me satisfactory evidence that on that occasion at half past 9 P. M. the most southern of these rings was about 300 miles wide (its northern margin being vertical over Newburyport, Mass., and its southern over Frederick, Maryland), and that it was about 43 miles from the earth—also that streamers near 580 miles in length and several miles in diameter, springing from this ring as a base, extended to a height of near 600 miles from the earth, the tops of the most southern streamers being vertical over Norfolk and being distinctly visible from Havana where they extended 23 degrees above the northern horizon. These streamers had a rapid but steady motion from *east to west*, that is they *revolved around the north magnetic pole of the earth in that direction.*

In this case then the lowest part of the auroral display being more than forty miles from the surface of the earth, where the rarity of the air must be fully equal to that attainable with the best air-pump, and the highest, extending far beyond what is ordinarily supposed to be the extreme limit of the atmosphere, it must be very difficult to imitate the whole phenomenon experimentally even if the subject were fully understood. But I desire to call attention to the very striking agreement between some of the essential features of the aurora, and phenomena observed by Plücker and Gassiot in their recent investigations in reference to the electric discharge in vacuo.

Prof. Plücker of Bonn, in a series of experiments on "the action exerted by a magnet on the luminous electric discharge passing through a tube or other glass vessel which contains residual traces of any gas or vapor," by passing the discharge from an induction coil through large Torricellian vacuum-tubes "of a cylindrical shape into which long wires enter from both ends," has succeeded in showing that the electric light passing from the negative wire towards the positive is "bent by the magnet into curves and surfaces."

He says (Proceedings of Royal Society, vol. x, No. 38, p. 258) "The magnet acts on this light in a peculiar way, having no analogy with phenomena hitherto observed. I easily discovered the law giving in all cases the exact description of the phenome-

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non. The light emanating from any not isolated point of the negative wire and diverging in all directions towards the interior surface of the surrounding tube *is bent by the action of the magnet into the magnetic curve which passes through this point.*"

"Such a curve is the only one along which an electric current can move without being disturbed by the magnet. It equally represents the form which a chain of infinitely small iron needles absolutely flexible, and not subjected to gravity, would assume if attached with one of its points on the point of the negative wire. It is well known that a magnetic curve is completely determined by one of its points. Therefore the whole light starting from all the different points of the negative wire *will be concentrated within a surface generated by a variable magnetic curve.*"

"The negative light partly depends upon the substance of the wire. Particles of it, either pure or combined with the included gas, are carried off to the interior surface of the tube, which when platina wires are used, consequently is blackened. If not acted upon by the magnet all the parts of the surface surrounding the platina wire become black; *if acted upon, only that line along which the surface of the tube is intersected by the magnetic surface is blackened. In this case therefore the particles separated from the wire move along magnetic curves.*"

"The importance of the use of magnetic curves or lines of magnetic force, in experimental researches, has been shown by several philosophers, especially Mr. Faraday. Hitherto only filings of iron enabled us to give, in peculiar cases, an imperfect image of these curves. *We may now trace through space such a curve in the most distinct way and illuminate it with bright electric light.*"

Dr. J. Baker Edwards, who subsequently made somewhat similar experiments, in speaking of the light of the electric discharge through an exhausted tube, says, (Proceedings of Literary and Philosophical Society of Liverpool, No. 14, 1859, 1860, p. 134), "When this column of light is made to fall over the pole of an electro-magnet it is attracted in the direction of the magnetic curves and *rotates rapidly around the magnet*, the direction of its motion being reversed when the polarity is altered or the direction of the current is changed."*

Now if in these experiments we suppose the electro-magnet to represent the magnetism of the earth—the negative wire the auroral "arch"—and the lines of magnetic light the auroral "streamers," are not the phenomena absolutely identical?

* On page 631 of the second edition of Silliman's Physics, recently published and which I had not seen when the above was written, is a figure and description of Geissler's form of an apparatus first contrived by De la Rive to exhibit this rotation. Prof. S. says, "if an electro-magnet is enclosed in the electrical egg, and a very perfect vacuum is made within it, when the induction current is caused to flow, *the electrical stream is seen to revolve in a steady and easy manner about the magnet, the direction of its motion corresponding to the polarity of the magnet.*

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In an aurora the centre of the corona being the vanishing point of the nearly parallel streamers which compose it, it is evident that a streamer having its base exactly in this centre (as *a b* or *c d*, fig. 1, Plate V,) must be seen absolutely endwise, and must appear merely as a bright spot in the centre of the corona—the line drawn from the base of this streamer to the eye of the observer (at A, or B, fig. 1) being a continuation of its axis. But it is found that this line always coincides with the direction of the axis of the dipping needle, at whatever place the observation is made, and, since the position of the dipping needle at any point on the surface of the earth is such that its axis lies in the magnetic curve passing through that point, it necessarily follows that the axis of the streamer in question must lie in a continuation of this magnetic curve, which for so short a distance may be treated as a straight line. Hence we must conclude *that every auroral streamer lies wholly in the magnetic curve which passes through its base.*

But an electric discharge from the parts of the atmosphere overlying the vicinity of the north magnetic pole, in passing toward the south magnetic pole, would, according to the law of Prof. Plücker, be compelled by the magnetism of the earth, to move along the magnetic curve passing through the point from which it starts. Hence as we find the auroral streamers occupying this very curve, presenting every appearance of streams of electricity, and revolving around the magnetic pole of the earth, just as Dr. Edwards observed the electric streams to do around the pole of the magnet, we seem justified in concluding that they really are *currents of electricity passing from the auroral arch on their way to the south magnetic pole, or perhaps to a corresponding arch surrounding it.* (See fig. 1, Plate V.)

If so it will probably be found that the phenomena in the two hemispheres, although simultaneous, are not identical, just as the appearances in the electric discharge in vacuo are widely different at the positive and negative terminals.

It is true that we have succeeded in tracing the streamers only five or six hundred miles, out of the many thousands they must traverse to reach their destination in the southern hemisphere, but their illumination even thus far beyond the supposed limits of the atmosphere is probably due in part to particles of matter carried from the arch, just as portions of the platinum wire were conveyed by the currents to the surface of the glass in the experiments of Prof. Plücker—and the invisibility of the streamers beyond this point may result from their great distance from the observer combined with the greater diffusion of the current and the absence of matter to be illuminated.*

* The experiment of Prof. Plücker shows that electric currents have a powerful tendency to transport portions of the electrode, the cohesion of even so hard a sub-

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Whatever may be the material constituting the auroral arch, it does not seem capable of penetrating the denser portions of the atmosphere but rather glides over them with a horizontal motion. Its observed form and motions may perhaps be most readily explained by supposing it to originate as a horizontal stratum of cloud, of a circular form, having its centre vertical over the north magnetic pole. Such a cloud, if repelled by this pole and attracted by the south magnetic pole, must, in commencing its motion southward (if there be any coherence between its parts) be converted into a ring, which would glide over the upper surface of the atmosphere, its diameter constantly increasing, like that of a circular ripple in water, as it moved towards the magnetic equator. In this case the ring itself would always occupy the position of a magnetic parallel of latitude; and the part of it visible from any place on the surface of the earth would appear as an arch with its ends resting upon the horizon and with its highest point on the magnetic meridian. Other similar clouds successively formed over the pole and then impelled southward would present the same phases, and when they were sufficiently near to each other, an observer would see several concentric arches, as is the case in some auroral displays.

The material composing the arch seems, in the steadiness and mildness of its light, its rolling motion, and cloudy appearance, strikingly to resemble the "glow" which is frequently seen in electric discharges in vacuo and which is very remarkable in some forms of the "stratified discharge." In the "Proceedings of the Royal Society," vol. x, Nos. 38 and 39, Mr. J. P. Gassiot, in giving the results of numerous experiments upon the electric discharge through his carbonic acid vacuum tubes, describes many varieties of the "stratified discharge." In some instances several luminous cloud-like concentric envelopes sur-

stance as platinum being insufficient to resist it; and the great height to which auroral streamers are seen to extend renders it probable that their visibility is due to matter so transported from the auroral arch—and since they are illuminated instantaneously throughout their whole length, *the velocity of the particles of matter carried up must approximate to that of electricity itself.*

The auroral columns shooting up instantaneously to such immense heights and maintaining their rectilinear form while revolving, as they frequently do, with great angular velocity around the magnetic axis of the earth are strikingly analogous to the tails of comets shot out from the nucleus with inconceivable velocity and maintaining their rectilinear form while sweeping around the sun, in perihelion, notwithstanding their prodigious length and great angular velocity.

Comets frequently approach so near to the sun that we might well expect developments of electric energy incomparably surpassing anything presenting itself upon the earth; and if auroral currents can transport particles of our atmosphere to a distance of several hundred miles beyond its limits we may readily conceive that similar forces may carry portions of the extremely rare material composing the envelope of a comet to a distance of even millions of miles from the nucleus. The suspicion may therefore be indulged that *the tail of a comet simply indicates the position of a stream of electricity rendered visible by its illumination of particles of matter which it is constantly transporting from the nucleus with the velocity of electricity itself.*

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rounded one of the terminals, whilst in others cloud-like masses of light were successively developed from one of the terminals, whence they passed towards the other terminal and were thus arranged in a line between them—their development being greatly promoted by the presence of a powerful magnet.

With a water-battery of 3500 cells, these are represented as faint and cloudy in their appearance; and with Grove's nitric-acid battery of 400 cells although the action was so intense that they became extremely bright they still retained their cloud-like form and motion. In describing experiments made with this battery, the exhausted receiver being placed between the poles of the large electro-magnet of the Royal Institution, Mr. G. says, "On now exciting the magnet with a battery of ten cells, effulgent strata were drawn out from the positive pole and passing along the upper or under surface of the receiver, according to the direction of the current. On making the circuit of the magnet and breaking it immediately, the luminous strata rushed from the positive, and then retreated, *cloud following cloud with a deliberate motion*, and appearing as if swallowed up by the positive electrode."

In another experiment with the nitric-acid battery Mr. G. says, "four or five cloud-like and remarkably clear strata came out from the positive." These were large lens-shaped masses arranged at regular intervals between the terminal wires, their flattened surfaces facing these terminals, as shown in fig. 2, pl. V, which is copied from Gassiot's figure (Proceedings of Royal Society, vol. x, No. 39, p. 401).

Now if in this case we imagine a small glass globe placed with its centre directly between the wires, it is evident that each of these cloud-like discs as it "came out from the positive" towards the negative terminal, must, while passing the glass globe be pierced by it, and be converted into a ring, (see fig. 3,) just as the auroral cloud was supposed to take the annular form in gliding over the spherical surface of the non-conducting atmosphere.

*This part of the auroral display may therefore prove to be some modification of the "stratified discharge"—the magnetic poles of the earth being the terminals, and the auroral arches being analogous to the cloud-like masses of light or glow described by Gassiot, the magnetism of the earth aiding in their development.**

* The following description of another of these experiments also seems suggestive of auroral phenomena:

"With the inductive coil the discharge in 146 exhibits a large cloud-like luminosity on the plate, which in those experiments was always made the negative terminal. On the positive wire minute luminous spots were visible. *At intervals apparently by some sudden energetic action, flashes of bright stratified light would dart through the vacuum*, but by carefully adjusting the contact breaker the discharge could be made to pass, producing a white glow on the negative plate, without, to the eye affording any appearance of an intermittent discharge."

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In the "London, Edinburgh and Dublin Philosophical Magazine" for December, 1860, Prof. Rijke of Leyden mentions that M. Perrot had shown that the spark from a Ruhmkorff coil consists of a bright point of light combined with a "luminous atmosphere that admits of being displaced by a current of air or gas," which he had succeeded in separating from it; and that while the ordinary spark is entirely unaffected by magnetic force, "*this luminous atmosphere appears affected in precisely the same manner as the voltaic arc under similar circumstances.*" Now as the voltaic arc tends to revolve around the pole of a magnet, this "luminous atmosphere" or glow must do the same; and if the material composing the auroral arch be of the same nature we should expect it also to revolve from east to west, or the reverse, around the magnetic pole of the earth—the direction of its motion corresponding with that of the streamers. In the display of August 28th, 1859, such was actually observed to be the case, the fragments composing the arch, as well as the streamers, having a rapid motion from east to west.*

The foregoing considerations seem to render it probable that the aurora is essentially an electric discharge (see fig. 4, Pl. VI) between the magnetic poles of the earth,—leaving the immediate vicinity of the north magnetic pole in the form of clouds of electrified matter which float southward through the atmosphere at a height of forty miles or more from the earth, sometimes to a distance of more than thirty degrees from the pole; that whilst they are thus moving forward with a comparatively slow and steady motion, or sometimes even remaining almost stationary for a long time, bright streams of electricity are, from time to time suddenly shot out from them in a nearly vertical direction —that is to say in the magnetic curves corresponding to the points from which they originate: that these curves, ascending to a great height beyond the atmosphere, then bending more and more southward and downward until they finally reach corresponding points in the southern magnetic hemisphere, are the pathways by which the electric currents pass to their desti-

* The grand display of August 28th, 1827, seems to have been of a strikingly similar character. In "Hough's Meteorology of the State of New York from 1826 to 1852," p. 487, the observer at Lowville says, "The arc remained entire three-quarters of an hour, its highest point being at first about 10° north of the zenith, one of its extremities meeting the horizon a little south of east, and the other a little north of the west point. *During the existence of the arc its constituent matter passed in a rapid and ceaseless current from East to West;* and soon after the arc was formed it began to move (the extremities however advanced but little) in a southerly direction, and continued its progress until it descended as many as 40° south of the zenith, it then *was broken up into parallel pieces which moved majestically westward*, and gradually diminished in magnitude and lustre, till at length every vestige of the arc disappeared."

In most auroras the arch is situated so far north that it is too distant from observers in this latitude to permit them to determine anything as to the motion of its parts.

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nation; and for several hundred miles from the earth these curves are thus "traced through space in the most distinct way and illuminated with bright electric light"—and further that the magnetism of the earth also causes these luminous currents and the electrified matter composing the arch to revolve around the magnetic pole of the earth, giving them the motion from east to west or from west to east, which the streamers and the components of the arch are observed to have.

DESCRIPTION OF PLATES.

Pl. V, Fig. 1.

N and S—The North and South magnetic poles of the earth.
n and *s*—The poles of an imaginary magnet representing the magnetism of the earth.
A, A′, B, and B′—Points on the surface of the earth.
ab, *cd*, *a′b′*, *c′d′* &c.—Auroral streamers.
ef and *e′f′*—Sections of auroral arches.
Z—The direction of the zenith to an observer at A.

The arrows show the position of the dipping needle at the several points A, A′, B and B′—and the dotted lines represent the magnetic curves passing through A and B.

An observer at A sees a corona having its centre at *a*—the streamer *ab* being seen endwise as a mere spot of light, and the streamers surrounding it appearing to diverge from it in all directions.

An observer at B sees a corona having its centre at *c*.

Fig. 2—Is copied from Gassiot's figure.

Fig. 3—Represents an imaginary modification of the same experiment.

Pl. VI, Fig. 4.

N and S—The North and South magnetic poles of the earth.

The East and West bands represent auroral arches, upon which stand the streamers. The dotted lines represent magnetic curves, and the arrow on one of the arches shows the direction in which the streamers, and the components of the arch revolved on the 28th of Aug., 1859.

Philadelphia, Jan. 31st, 1861.

Art. XXVIII.—*Remarks upon the Atoll of Ebon, in Micronesia;* by E. T. Doane.

We will begin our remarks upon the Atoll of Ebon by referring in a general way, first, to that section of Micronesia which embraces it, known as the *Marshall Islands*. The name is that given by *Krusenstern* in honor of Capt. Marshall who made the first discoveries there in company with Capt. Gilbert. The discoveries date back seventy-two years; the first island was seen in 1788, the last being discovered only in 1824.

The whole group lies within the longitudes 166° and 172° east, and 4° 39′ and 12° north latitude. Of the atolls of the group, some are large, measuring forty, fifty, and sixty miles in circumference, while others are mere bank-reefs, two or three miles in circumference. Of the large islands, we may mention *Jaluit* or Bonham's *Rimski Korsakoff*, or *Rong-rik* and *Rong-lab*,

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and *Mille* or the Mulgrave Islands. Of the mere bank-reefs, we may mention *Kili* or *Hunter's* and *Lib* or *Princess* Island. And we would here remark, perhaps no group of the Pacific presents a more tangled mass in the nomenclature of its islands, than does the Marshall Islands, and especially the Ralik range. Some of the terms we have given above may perplex the reader as he attempts to trace them out on ordinary charts.

The Marshall Islands are divided by a deep sea about one hundred and fifty miles wide—into two chains—the Eastern or *Radak*, and the western or *Ralik*. Their general bearing is N.W and S.E. The Eastern chain possesses thirteen atolls and the western sixteen. The general features of these atolls are similar to those of most coral islands. They are low—the reef-rock in none probably measuring more than ten or twelve inches in elevation. In form, however, there is much diversity. *Mille* or Mulgrave island is nearly a parallelogram—*Majuro* or Arrowsmith is oval; *Ebon* circular—while *Jaluith* or Bonham's Island and *Arlinglab-lab* or *Elmore* Islands, and many others, are without any definite forms.

The atolls vary in fertility. Those south of 8° north latitude possess, from all native accounts, the most fertile islets and the most available soil. Their fertility may be accounted for from the fact, that more rain falls upon them. They are more affected by the equatorial belt of "constant precipitation" which is ever oscillating backwards and forwards over them. Dead leaves and wood rapidly decay.

It is an interesting fact, anomalous to the general features of coral islands, vide Dana's Coral Is. p. 24—that the *leeward side* of these islands possesses the largest body of land. Indeed the windward side of many of these islands is entirely destitute of land—or possesses it only in small islets. On *Mille* or *Mulgrave* Islands and *Majuro*, *Arrowsmith*, *Jaluith*, *Bonham's* Islands and *Ebon* islands which the writer has visited, this is emphatically true. The windward side of *Majuro* is possessed only of small islets, while the leeward side is one continuous strip of land, twenty-five miles long. *Jaluith* is much like this; perhaps, however, it has not so continuous a piece of land on the leeward side—though there is here the most fertile soil. On *Ebon* this is likewise true.

An explanation of this fact may perhaps be found, in the strong winds—the "N.E. trades" sweeping with all their force for one half the year over these reefs. These strong winds and the heavy sea they raise, tend to sweep off the material which might accumulate there; and bearing some portion on across the lagoon to the leeward side is there lodged, and helps forward most rapidly the accumulation of the "beach formation."

The fact has been stated, that the northern atolls of the Mar-

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shall islands are rather subsiding than otherwise; vide Dana's Coral Is., p. 134. It may be asked, is this not rather apparent than real? May not the small amount of wooded land found there—for this is the basis of the statement—be owing rather to the heavy seas and winds which there prevail? The natives ever speak of the heavy winds of that latitude, 12° N. Islands have been desolated by them. We feel disposed to offer this as a solution of the fact.

Another fact, we would state as common to the whole group —is the existence of large ship channels on almost every side of the lagoon. *Mille* possesses four large ones—three of them, and one, the largest of all, on the windward side. *Jaluith* has its reef pierced by as many—and much in the same position. While *Majuro* has its channel on the windward side only, and *Ebon* on the leeward, we cannot speak of more from personal observation—though the natives say the other islands possess many channels and in much the same position of those above mentioned.

With these remarks upon the general features of the Marshall islands, we proceed to remark upon the atoll of Ebon.

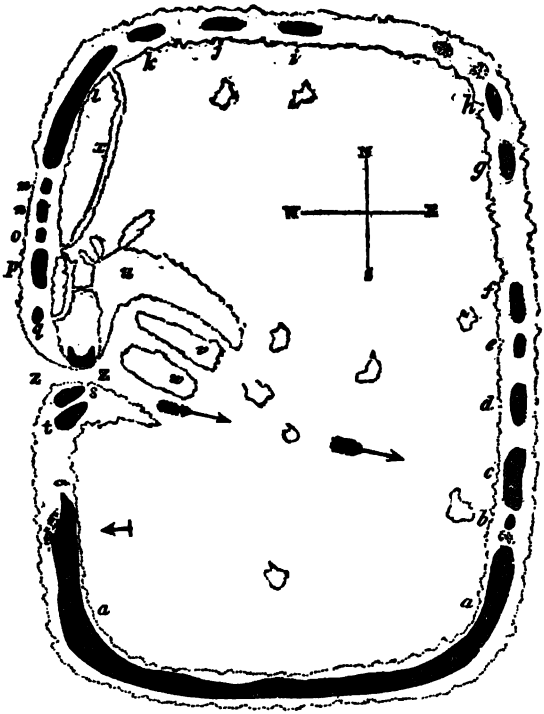
The position of this atoll is 4° 39′ north latitude, 168° 49′ 30″ east longitude. This is the position, from the anchorage of the ship "Morning Star" in the Lagoon. The atoll is the most southern one of the *Ralik* range. It was discovered May 25th, 1824, by Capt. George Ray who named it Boston Island. In 1834 Capt. Covel thought it a new discovery, when it took his name, by which it is often called. The atoll is nearly circular and measures some twenty or twenty-five miles in circumference Except the passage on the west side of the reef, there is no other, not even a boat passage, in the whole circumference of the atoll. The reef however, at full tide, can be crossed by native craft. There is a tradition that once a passage existed, of sufficient capacity to admit ships, on the N.E. side, and that it was destroyed however by some powerful spirit, in his rage, and the present passage opened.

The natives possess also an interesting tradition concerning the existence of *a high island as having once occupied the most of the lagoon.* It is said the tall hills, covered with bread-fruit and cocoanut, reared themselves where now the flats in the lagoon exist. It is said also that what must then have been the barrier reef possessed land, which is now Ebon islet. The present passage is twelve or fourteen fathoms deep, and at the inflowing and outflowing of the tide has necessarily a very strong current, being the only outlet for the whole lagoon—when the waters are lower than the reef. As it flows in, against a strong wind, its presence may be traced quite across the lagoon, from the ripple of the waters and the white caps. The reef-flats near the passage in the lagoon are being covered with sand and other

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coral debris—the nucleus of some future islet. The small coral patches in the lagoon are all covered with a few inches of water at low tide.

Ebon is the largest islet on the reef, as shown on the accompanying sketch—and gives name to the whole atoll. Its length from point to point is about eight miles. A singular feature is found upon it, a ledge of coral conglomerate. The map by the sign ↤ presents its position. On the north end of the islet it projects itself free from all soil or sand; and its course as marked, can easily be traced by its repeated outcropping. The land which lies on the sea side is of considerably more recent formation than that on the lagoon side. The difference is very perceptible. The ledge or embankment was formed, no doubt,



a, Ebon; *b*, Dile; *c*, Eniaithok; *d*, Kermkumlab; *e*, Eri Mon; *f*, Remrol; *g*, Koie; *h*, Minlak; *i*, Enear; *j*, Enikaiori; *k*, Riri; *l*, Toko; *m*, Bikri; *n*, Bivilil; *o*, Aneming; *p*, Enilu; *q*, Iu; *s*, Jurith; *t*, Eni-armith; *u*, Worai-thok-thok; *v*, The Komil; *w*, Morelab.

mainly from the wash of the lagoon. This is seen from its lamination sloping that way. It undoubtedly served an important purpose in catching and holding the finer materials thrown up from the lagoon.

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At the S.W. bend of the islet the surface is quite uneven,—hills and vales in miniature form and size show themselves. They are formed no doubt by the drift of the sand—blown up into little hillocks. From its elbow round to the N.E. point the islet possesses but little soil. It is however covered with a quite heavy growth of bushes and trees, all possessing a very rich and deep green color—and this is indeed characteristic of the foliage of the whole island. It has none of that sickly yellow, half nourished hue, which we find upon many coral islands—those especially of the Kingsmill group. On Ebon all the growth is beautiful. There is soil and rain enough to nourish well the tropical vegetation.

I have not been able to obtain an exact classification of the plants of this atoll. More than fifty distinct species, however, will be found. We will mention some which enter chiefly into the support of native life. The Artocarpus is represented by some eight or ten varieties, one, the *A. integrifolia*—and the rest *A. incisa*. The *Pandanus odoratissimus* is represented by some twenty varieties. Its fruit enters largely into the native food. It is prepared in large rolls enclosed with its own leaf,—and may be kept for years. The cocoanut (*Cocos nucifera*) is represented by some ten varieties distinguished only by the nut. Two varieties of tarro (*Arum esculentum*) is quite plentifully grown. It is raised in large beds prepared somewhat for it. These beds differ from those found on the Kingsmill islands. They are not as there, excavations carefully worked out and good soil prepared and worked in. They seem in a measure to be natural excavations, perhaps the sunken hollows between hillocks. These hollows with some little preparation would answer the purpose:—at least their origin at this day is unknown. If a native be asked concerning them, he invariably refers them to the work of spirits. Around the margin of these arum patches, are grown bananas in quite plentiful crops. And the larger islets have just sufficient to raise oranges and figs, which the missionaries are now growing.

This atoll is the home for a few varieties of birds. But in this feature of the island, the contrast is as wide between the "low coral" island and the "high volcanic" one—as between their natural features. The high islands of Micronesia are largely supplied with the feathery tribe,—but this atoll can claim only a very few birds—and with two or three exceptions these are all water fowl. There are a few Columbidæ, *Carpophaga oceanica*, which manage to elude the keen search of the natives. These birds are occasionally heard cooing away in the tops of some quite isolated bread-fruit tree. A Cuculus gives forth occasionally its sharp whistle—and these, with the addition of another land bird whose species I have not been able to learn —are all the feathery songsters this atoll can claim.

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The shores of the reef at low tide, and the bare rocks, are a little enlivened by the brown and white Heron. Small flocks of snipe (*Scolopax*) gather on the sand bars—or single individuals are running along the beach picking up food. An occasional plover (*Charadrius*) is to be seen. Sea swallows (*Sterna stolida* and *Sterna minuta*) are skimming the waters of the lagoon, or resting on the beach. A Booby (*Lula*) now and then is seen sailing over the island. His home is unknown to the natives. His want of caution is clearly seen in the easy way a native will ascend a tree in which the bird is roosting and with a slip-noose capture him. An interesting explanation of the origin of the single variety of the *Cuculus* is given by the natives—so skillful has this bird been in concealing its birth-place. As the natives find it only full grown they say that it is born and nourished in the clouds and falls to the earth of full size.

At least five species of reptiles are found on the atoll. Four are of the Lacertinidæ—and one, Geckotidæ. The Gecko readily domesticates himself, and lives upon the house flies and gnats he finds. The Lacertinidæ find their homes on trees and bushes.

The varieties of insects are interestingly numerous. It might seem as though these atolls, so comparatively recent in their origin would be but feebly represented by any varieties of animal life. But the entomologist will find here not an uninteresting field of study. The most common kind of insect is the parasite *Pediculus*, disgustingly numerous in the heads of natives; a large size Libellula, dragon fly, is quite numerous, and a few of the diurnal and nocturnal Lepidoptera are found. Of ants and mosquitoes and flies there are large swarms. Of the *culex* there is probably a new kind, which might be called *diurnal* culex. They are very small and almost as numerous as those more commonly seen at night. Of Scolopendra—Centipedes—there are many to be found and of rather formidable size—though we rarely hear of their biting any one.

There are several varieties of Spiders. The scorpion, though found on the atoll is small and harmless.

The Crustacea are numerous on land and in the water. We seem to have a great abundance of the Paguridæ—hermit crabs. I have thought they were more numerous on these coral islands than on the volcanic ones.

The Mollusca too are abundant. Some rare specimens are found. The orange cowry is common to some of the Lagoons. Zoophytes also are numerous, as would be supposed in these waters. A valuable and quite abundant sponge is also found in some of the lagoons and the Marshall islands.

It will be noticed, on the reef of this atoll, that besides the islet of *Ebon* there are nineteen others. All of them are much smaller than Ebon, though for their size they are equally fertile. Some of them seem to be veritable fairy-lands—so soft is the

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green grass which covers them—and the deep shade of the interlaced bushes and majestically tall bread-fruit trees, throwing out their long sweeping arms like the monarch oak—

—"Who has ruled in the green wood long."

In the growth of some of these islets, we have perhaps some interesting facts connected with the rate of growth of islets or coral reefs. *Bikri* is an islet containing not more than an acre of land. A few Pandanus self-sown from seed washed there by the waters of the lagoon or sea, have taken root. And there are a few bushes,—a variety which I have noticed as growing only on the frontier soil of an islet—soil which is but little more than sand. From the leaves of these bushes and Pandanus, soil is very slowly forming. But *the present age* of the islet is, as stated by a native, who saw it when only a *sand bank* washed by the tides—some *thirty-five years*. He remembers it when a boy as only a sand bank. Now it has a *little* soil and *few bushes*. The islet *Nanming* he describes as once only a sand bank. It is now about the same size and condition as *Bikri*. These facts are not stated of course as definite for determining the rate of growth of coral *islets*—for into such a calculation many other circumstances might enter, such as the position of the reef for catching and holding the washed-up matter, &c. But we may learn from the facts here given, that the growth of land, like the growth of the reef-rock, *is very slow*.

Near the southern extremity of Toko (opposite *x* on the map) some *thirty-five* years since, there was a passage sufficiently large to let a proa pass over the reef between what was then *two islets*. Now that passage has been filled up, and large bushes grow there. The only tree of any size is the cocoanut and Pandanus, which have been planted. This fact we would state as illustrative of two points—one bearing on the fact we have just referred to—the rate of growth of an islet—and the other, that large islets are made by stringing as it were, together several small ones. It may be questioned whether a large islet, say some two or three miles long, is one continuous production; it was rather formed by several smaller islets becoming attached and the whole in time becoming one large islet. This fact I think can be clearly proved to have been the case with the growth of the islet of Ebon. There are several spots which may be indicated as the *welding* points of small islets. These places are usually narrower, and less overgrown with bushes and trees, and possess a thinner soil than other parts of the whole islet. Then again there are places which are *expanded*, just as if they had been the central nucleii of the islets. These are heavily wooded—have large bread-fruit trees and other trees of apparently an old age, growing upon them. We have reason to believe that all the islets of this atoll will in time be thus united, and thus the

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whole reef possess, so far as it goes, one unbroken chaplet of vegetation.

We are now deeply interested in watching the formation of *sand banks* at one or two points. As yet they are shifting about —as the winds and seas prevail for a given time from any quarter; they are as yet covered by high tides. One of these sand banks is between *Eni-armeth* and the northern point of *Ebon*. We may not live to see it, but we believe that this sand bank will yet become *fixed*—will enlarge itself—catch some floating seeds and appropriate them and then there will be another green islet on the reef. This will again expand itself and become the connecting link of Ebon and Eni-armath—thus completing the length of the green band of this Ebon islet on its northern extremity.

Ebon Atoll, Marshall Island, Micronesia, Aug. 16th, 1860.

ART. XXIX.—*On Normal quasi-Vision of the Moving Blood-corpuscles, within the Retina of the Human Eye;* by LEVI REUBEN, M.D.

I. WHILE observing, in the summer of 1857, the apparent changes in the colors of natural bodies, due to transmission of the light from them through various colored media, I looked through a thick plate of deep blue cobalt glass at a clear, bright sky; and upon so doing, I at once noticed an appearance of movement of numerous minute, shining or lucid points, and seemingly in the space a foot or more forward of the eyes. These appearances, as then and often since observed, may be thus described:

1. The earliest impression was that some of the lucid objects showed as mere points, others as bead-like bodies. The bead-form is, however, in this experiment, an illusion, and due to a quick circuitous movement of some of the points.

2. The movements were by regular impulsions, or in jets; and as if, at each jet a new troop of these objects entered suddenly in all parts of the field of view—these moving, as the eye would pronounce, distances varying from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch, and then mainly but not all disappearing just before the next accession.

3. Owing to the quick movement, the effect was as if so many fine lucid lines were rapidly traced; and these were seen at the same moment, throughout the whole of the length already named; or, sometimes, the first formed extremity of the line was observed to vanish first. The lines were apparently not of light or color, but rather of *glistening*, or *lustre*.

4. The jets were *always* sensibly synchronous with the pulsations of the heart; the duration of the lines, from the half to the whole of a pulsation.

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5. The movements were in all directions; in lines straight or contorted; generally indicating some divergency from certain points or from along certain lines; and only to be traced after some practice.

6. Thus aided, however, it soon became evident that, as long as the eye was not shifted, the moving objects kept in each part of the field to certain directions, upward along one narrow band, downward or obliquely along another, as if confined to particular channels or paths.

7. The blue glass showed the movements best; but the eyes were not at the time actually directed to the apparent place of the sky, but so that the optic axes met in the space seemingly occupied by the moving objects—not more than four feet from the eyes.

8. With this glass, there was no difficulty in converging the eyes to this space. The objects appeared so distinct, that the vision seemed involuntarily adjusted to them.

8. Yet it was easy to observe that if the eyes were forcibly directed to the sky, or if in any way the direction of the axes to the apparent field of the shining points was lost, the latter were less distinctly perceived; and with media of most colors other than the deep blue, were wholly lost.

The facts can only be reconciled with the hypothesis that the lucid lines are quasi-visible traces of the corpuscles of the blood moving in vessels in the retina; and that they were such, I became convinced during the first observation of them. That the blood can be only that of vessels *in* the retina, becomes certain when we remember—

a.—That these vessels lie in the anterior half-depth of the transparent retina itself,

b.—That the vessels of the choroid coat lie behind the retina or laterally to it, and imbedded in absorbent or black pigment.

c.—That in the eye, subsequent to birth, there are no vessels other than those in the retina, that lie in the course of the cone of rays admitted by the pupil.

Thus, these apparently trifling observations acquire at once both a physiological and a psychological interest, as showing the visual surface and the objects positively impressing it brought, certainly, to their extreme limit of contiguity! I have called this *quasi*-vision, because it does not arise from the presence of any object the rays from which are brought to foci by the crystalline lens; that is, the case is not one of ordinary vision. Yet there is a *positive impression* on the retina, and of just such kind that the mind interprets it into the vision of real, glistening objects in the air. The cause is a *subjective* one (physiologically considered); but the perception (so far as the mind is concerned), is clearly *objective* and *real*. That the phenomenon was not due to

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any condition of my own eyes, I determined in my first experiment by desiring several others who were present to look toward the sky through the blue glass: every one (among them a little girl not quite seven years of age) readily discovered and correctly described the general characters of the movement.

With *lighter blues*, the moving points were less distinct and fewer; through a *deep green*, pretty distinct; but faintly and not easily visible through *light green*, or through *orange*. Subsequently I discovered them in tolerable distinctness on directing the unaided eyes toward the sky, or toward cloud-surface not too dark. In all these cases, diffused or daylight was the agent of vision. With all but the *deep blue* or *green*, or a *bluish-green* glass, considerable practice and some effort are requisite in order to *focus* the eye properly, an effect that seems to be secured at the same time with the converging of the optic axes on the proper field, for each hue employed. The greatest difficulty is experienced, as later experiments have shown, with *yellow*, *violet*, and *red* glasses; and with these, consequently, the vision of the lines is very fugitive and uncertain, while their number is small.

In Mackenzie's "Diseases of the Eye," the phenomenon, as witnessed by the unaided vision directed toward the sky, is mentioned as having been noticed at different times by different observers. I am not aware that before the observations I have now detailed, any one had noted the special applicability of colored media, or the superior vividness afforded by use of the cobalt-glass.

Regarding this glass as *dichromatic*—cutting off mainly both extremities and also the rays of the middle of the spectrum transmitted through it, and allowing the passage of two bands chiefly, the one blue, the other a hue of red, I was first led to believe, that, in connection with action of the blood-discs as lenses, dichromatism in the medium furnished an explanation of these phenomena. And, according to Wollaston's analysis of the light reflected from the atmosphere, this is comparable to that of a dichromatic medium, blue and red being also marked elements in it.

The substance of the results now stated, with an exception or two not touching the essential features of the phenomenon or explanation, I presented before the Photographical Society, of this city, June 13th, 1859, and more fully at the meeting following. Not then finding leisure to follow out my intention of offering an account of the subject for the pages of this Journal, I furnished a brief statement to Mr. Seely, and it appeared in the *Journal of Photography* published by him, July 15th, 1859. Professor Rood's observations, in this Journal, September, 1860, recalled the consideration of the subject, especially

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as I was already able to add some other and quite as singular aspects of the phenomenon. Even before that date, I had also observed the appearance named in Prof. Rood's second note (Nov. 1860), of the field of view resolving itself "into a mass of small, round, densely packed moving bodies," or rather into several currents of such, moving in different ways; and though without publishing it, had mentioned the fact before the Society above named, giving, however, a different method by which the appearance could be secured.

Prof. Rood considers the lucid traces as *yellowish* in color; and explains them as due to complementary color subjectively arising, in a retina generally impressed with blue rays, along lines in which by passage of yellow blood-discs the blue light is momentarily intercepted. He admits, however, the fact of some appearance, even with the use of a *green*, *red*, *orange*, or *yellow* medium. He deems the indigo and violet rays as mainly influential in the result with the cobalt-glass. Let us recollect, however, that the *yellowness* of the stain of dilute blood is apparent only; the color of one or a few layers of blood-corpuscles must be a *tint* of the same hue possessed by the blood in mass, *i. e.*, of some hue of red. Then, on the hypothesis of complementary color, a *bluish green* glass (the complement of red) should show the phenomenon best; but it does not show it, so far as I have discovered, nearly so distinct as the cobalt-glass. Again, on the same hypothesis, the blood should be of the hue complementary to that of the cobalt-glass, namely, a *yellow* or *greenish-yellow;* but it is in fact red. Furthermore, a violet glass should show the appearance quite distinctly: it really does so only with the greatest difficulty, and then very few points. I have found that, with a yellow or orange glass, the points are few, but marked and bright; and with this medium they are still better seen by the reddish-yellow transmitted light directly following sunset, or at mid-day against whitish and highly illuminated cloud.

Thus I am led to doubt whether the explanation of the appearances can possibly be that they are due to complementary color. The yellowish hue of the lines is not always apparent (to me) with the cobalt-glass; but glistening or brightness always is. With glasses of other hues, it is very doubtful whether the lines show anything like the complementary colors. May not, then, the yellowish hue sometimes appreciable with the deep-blue glass be rather an incident, than in any way essential to the phenomenon? On the other hand, it is quite certain that the various colored media showing these moving points can not all be capable of a dichromatic effect on the transmitted light; so that, while this effect may, when present, operate in intensifying or otherwise modifying the phenemenon, I am led to consider the true cause of the latter as to be sought *in some effect of the*

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*blood-corpuscles, acting as lenses, upon the minute pencils of converging and already almost focalized light entering the retina.**

II. In the communications already referred to, certain other facts and principles were stated, which I will briefly recapitulate, taking the liberty to present more clearly some points before implied:

1. Some of the lines did not remain lucid throughout; but before disappearing, along full half their length gave place to a distinct *black* line. This I have repeatedly observed; the change is marked and unmistakable. But owing to the brevity of the whole movement, I at first erred in judging that it was the last-formed half of the line that became black, and that the black portion was the narrower. I have since ascertained that it is the *first-formed half* of the line that becomes black, and either very soon, or just before disappearance; and what is strange, this is uniformly the fact, except that in rare instances, to appearance at least, a line is traced that is black throughout and from the first. The supposed narrowness of the black line also seems to have been an illusion, but one readily accounted for on the principle of the tendency of any distinct luminous impression to extend itself upon the retina.

2. On looking with one eye through a pin-hole in white paper near to a bright gas-flame, and a little obliquely or to one edge of the opening, the bright lines appear; but now the motions are far more rapid and through longer sweeps, resembling very much, except in the brightness of the lines, the play of the eel-like animalcules of a drop of vinegar through the field of the solar microscope. With white paper and the yellow gas-flame, the lines are always of a light bluish-green. Along with and behind the lines, there is usually a mottled appearance, as of patches of bead-like bodies, either stationary, or in apparently slight commotion. Query: appearance of cells forming parts of the anterior layers of the retina?

3. At other times, owing to some slight and uncontrollable shifting of the adjustment of the eye, there appears, in like tint, a wholly different view: the field is now mainly occupied as with a pavement or floor of the small, stationary bead-like bodies; but in the middle of it, always in the very axis of vision at the time, there is a wholly vacant roundish space, apparently if not quite of the size of a three-cent piece. This I have very often witnessed; and the general characters of the appearance are constant.

4. This apparent opening or vacancy through the pavement-covered field of view, having its center always in the axis of vision, at once suggests that the phenomenon is another view of the cells or granules forming certain layers of the retina, but which for some reason are not to be detected over that slightly

* See a note on the Color of single blood globules, in this No., *Scientific Intelligence*—PHYSICS.

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elevated portion of the membrane corresponding with the *foramen centrale* and *limbus luteus*, or "yellow spot" of Soemmerring, and which is the seat of most distinct vision. It is difficult, however, to account for the non-appearance of the cells at this point since, anatomically, (beside the fact that the entrance of the artery and the insensible spot of the retina are close to or within its area, on the inner side), the only differences of structure from that of the other parts it presents, are greater tenuity as well as sparseness of nerve-filaments, and the want of the deepest or granular portion of the gray or sensific layer of the retina. Conjectures indeed, may point to the thinness of the retina here as the cause of disappearance of the anterior layer of cells; or, one may even assign this vacancy as the magnified area of the insensible spot.

5. Let it be remembered, further, that though the posterior layers of the retina are of *gray* or vesicular nerve matter, yet the layer is so thin that the color must be quite ineffective; so that the retina through its whole depth is nearly as transparent as water. A consequence is, that this membrane consisting of an expansion of the optic nerve and of ganglionic nerve-substance back of it, is not, as commonly taught, a *screen*, receiving a picture having superficial dimension only; it is, on the contrary, a minute *depth* of impressible though transparent tissue; so that retinal images generally must have *depth*, as well as *area*, and we may say, a real, though in one direction quite limited, solidity of form.

6. Now the red blood-discs, the most numerous variety, moving in the vessels lying directly in front of, and partly in, the impressible portion of the retina, and, which, in the small capillaries are probably separated in most instances so as to advance singly or in very small groups, become comparable to so many minute *lenses*, shot at every pulsation in various directions athwart and in the transparent mass of the membrane. If the capillaries are large enough to admit discs without compression, they remain slightly bi-concave, and supposing them to differ in density from the blood and the retina, their effect must be, if they lie with the concave sides transverse to the rays of light, to overcome part of the convergency given by the crystalline lens, or to cause the minute pencils transmitted by them to diverge. If, however, they present themselves edgewise to the light, *i. e.*, if their concavities are transverse to the paths in which they are advancing, then we may suppose, either, that in the direction vertical to their path they act as convex lenses; or that, while this is the case, certain rays entering at their edges in such part as to strike afterward, from within, either of the surfaces that are outwardly concave, and of course inwardly convex, would undergo total reflection, and so an additional effect of concentrating or massing together the rays would occur, the whole being

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brought to a focus more quickly or brighter in itself; and thus, the disc would project this bright pencil just beyond it into the impressible layer, and necessarily carry it along with its own motion. But if the capillary, as is sometimes the case, be too small, so that the red corpuscle becomes wedged, then it has been observed, under other circumstances, to be variously changed in form, usually inclining to globular; and the latter is the form also of the few white corpuscles contained in the blood; so that in these instances the effect of a minute spherical lens is secured or approximated.

7. But, are the corpuscles more dense than the serum and the nervous mass, so that they can act as lenses? It is well known, first, that the specific gravity of healthy blood slightly exceeds that of *brain;* and I shall have to assume that the density of the retinal substance is not essentially different, as its composition and structure are not, from that of brain. But again, in blood whose coagulation is delayed for a few minutes after withdrawal from the veins, the red corpuscles are found rapidly sinking through the liquid, so that the clot thereafter forming is at top yellowish only, or of buff color, and the serum is quite red. The white corpuscles are to a greater extent entangled in the clot. Hence, it must be inferred that at least the red corpuscles have a density distinctly greater than that of the blood, and in all probability, than that of the retinal mass; and this is all that is necessary to show that they *must* act as lenses upon any light which they can transmit.

8. And this brings me to the question, can the *red* blood discs transmit light of any hues, even green or blue? It must be recollected that, in the minute capillary vessels, these discs can no longer advance in masses of several in thickness, but must advance singly, or at most in layers of two or three deep. In such a case, the blood-discs can hardly present a hue deep enough to render them effectively colored, that is, *opaque* to their complementary color. The thickness of two red corpuscles advancing side by side with their longer diameters presented in the direction of entering rays, would not exceed in all about the $\frac{1}{1400}$th of an inch. Now, let us suppose a solution of the same absolute intensity of red as that of the blood, introduced into a wedge-shaped glass of very gradual taper, and in which the film could, near the edge, be brought to a thinness of $\frac{1}{1400}$th of an inch: how much of the spectrum would the red medium at this degree of tenuity cut off? how much of the intensity of a green or blue beam would it destroy? Inappreciably little, it appears to me; and this view is sustained by an experiment named in Prof. Rood's paper. He says: "Yellow solutions, when combined with the blue glass or blue solutions, render the circulation invisible; and it does not re-appear till the yellow solution has been made *so dilute as barely to preserve a yellow tint, and to transmit the spectrum*

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almost unaltered." The words which I have here italicized describe exactly what is true in regard to the *red tint* of dilute blood, and of course of the single attenuated streams of blood in the capillaries. The experiment itself disproves the possibility of a real or effective opacity of the blood-discs for green or blue rays. In seeing a blush on the cheek of another person, the eye takes in at once the hue of tens of thousands of closely aggregated capillaries; and here the intensifying effect of concentration is experienced. But in witnessing the movement of the blood in the retina itself, the field is as it were spread out, and near objects thrust apart; and the effect of each pencil so small as to pass through one corpuscle, or two or three in succession, is noted by itself; so that no intensifying of color by mere contiguity can here occur.

9. The explanation I was at first inclined to give of the quasi-visibility of the moving blood-discs, by use of the cobalt-glass or against blue sky or cloud simply, was that of regarding it as an instance of *glistening*, adopting Dové's theory, (as modified by Brewster,) that the perception of glistening or lustre is consequent in some way upon the mental effort to reconcile or combine images formed at slightly differing depths in the retina. The lights employed in the cases now named, or at least in the first two, have prominent a blue and a red pencil. These are of refrangibilities considerably differing. Now, the eye not being perfectly achromatic, the several prismatic colors are focalized at the same time at slightly differing distances from the lens, *i. e.*, at slightly differing depths in the retina. In case of white light, or colors nearly allied, there is so close a sequence of these images, and they overlap, or rather, inter-permeate each other, so nearly, that their hues blend into a single resultant image, white or of the dominant hue, with which the mind occupies itself, the colored borders, or rather *surfaces*, of the image being relatively so slight as to escape perception. But when a dichromatic beam passes to the retina, certain intermediate hues having been mainly eliminated by the medium, there are two images or sets of images that do not so nearly coalesce; an image by the more refrangible rays placed anteriorly, and one by the less refrangible, posteriorly, within the retina. But, bi-concavity of the corpuscles would diverge, say, the blue rays more than the red, producing increased brightness along certain moving points back of the corpuscles, where the two kinds of rays would then come nearer to one focus; or bi-convexity would affect the blue rays again the more distinctly, in the way of increasing the convergency before given by the crystalline lens; and thus the two images might be still more separated, and the effect of glistening, or no sensible effect, should then be anticipated. But, since it is not supposable that yellow, red, and certain other glasses transmit more than one sheaf of closely-allied hues, the supposition of dichromatism fails to be

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applicable to these; and being set aside as but an incidental, possibly a modifying circumstance, no probable hypothesis other than that of action of the corpuscles as lenses seems to remain.

10. Another curious phenomenon I early observed, and one for which I have not been able even to imagine a cause. It appears with most of the media used, especially with the darker colors; and usually precedes or attends the vision of the shining traces. It consists in the vision of many very minute but very real black motes or points, that do not sweep off, but are in rapid and considerable agitation, or *swarming*, as it might be termed, over the whole field of view. These appear to be more distant than the lucid points, and equally diffused; and they are seen very constantly.

11. In Professor Rood's second paper, he speaks of the "densely-packed moving bodies" already referred to, as being seen when the light of a salted wick is condensed on the eye, and better when a yellow glass is interposed; and he adds that Professor W. B. Rogers obtains the like appearance by fixing the eye on a bright surface, until that organ is fatigued, or looking through a tube of black paper at a white surface. In my later experiments, made the last summer and autumn, I was surprised at finding this effect produced on closing one eye and laying over the other, open, a paper, white or of any hue not too opaque, and standing with this eye near to a bright gas-flame. The quiet steady flow of minute objects is soon discovered more or less perfectly forming itself in the field of view; it grows more clear, and is seen to consist of many streams in different directions, each keeping its own course; and the appearance suggests streams covered with fine floating ice. But the eye must be rightly focused, looking apparently into the space quite near to it; the appearance easily vanishes, and is hard to recover. It may be observed when a leaf of an ordinary book is laid over the eye, under the circumstances named, or when yellow, greenish, red, or other paper not too dark is used. The color of the objects approaches more or less nearly that of the complement of the medium. The steady flow of the bodies seems to show that they cannot be the same as those seen with the blue glass; and appears to intimate that, while the latter are in the arterial extremities or in the first extremities of the capillaries, so that they still feel the impulsion of the heart, the "floating-ice" objects are in the radicles of the veins, where their propulsion is uniform and their numbers greater.

III. The following notes I select from among such as I have taken down during some of my latest experiments, the past autumn:

a.—With a bright sun; view of the sky about 20° from the sun, through the cobalt glass: When the lucid lines are best seen, and

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the eyes adjusted to their place, there is always at the same time a pretty distinct consciousness of the back-ground (sky or cloud) as distant, and as being, directly before the eye, *mottled* with prismatic colors, faint but real; sometimes taking the appearance of mosaic pavement, or of small colored *cirro-cumuli;* so that when the glass is aside, one is disappointed at seeing no cloud, or one of different appearance. In this case, the colors seem mainly *blue* and *red.* The effect I had somewhat unconsciously noticed before; have seen it very positively many times since. Sometimes the appearance is that of fine colored powders mixed; sometimes it is, though faint, quite beautiful, as if the groundwork were of confused rainbows. It is seen more or less distinctly with glasses of nearly all colors. But it vanishes the moment the eyes are directed to the sky, and may reappear when they are again focused to the near field of the moving discs.

b.—Same time, and medium: the lines are mostly lustrous only; very few give even a faint impression of yellow. The spot in the axis of view has least in number; and the eye catches more as it is turning a little to one side. Best seen when the eyes converge to the objects.

c.—Against same sky, through single amber yellow glass: the moving points seen as minute, not colored, few, very bright, quick-moving, and fugitive. Through two thicknesses of the same glass: points fewer, and more fugitive, but quite well defined.

d.—Through dark green formed by combination of yellow and light blue: Looking long and steadily, the eye finds the field of the objects, and so adjusts itself as to see many of them, though only tolerably distinct.

e.—Through grass-green glass: The shining lines readily and distinctly seen; a few quite defined. They show *no tinge of red.*

f.—On another occasion, with the cobalt-glass, against the sky: all the phenomena beautifully made out; the more distant swarming, black points plentiful; the traces of the blood discs numerous and distinct; and a considerable proportion of them turning to black lines just before disappearing.—the black line always at the end first or longest formed, and extending down to a defined extremity, where it *abruptly* changed to, and was continued by, the lucid portion. I could not, however, make out that the black line began at the first-formed extremity, and ran down the course of the whole line; though this may have been so. The black and the bright portions both suddenly and completely disappeared.

g.—Same time, and medium: Found, very evident and certain, a larger channel or spot of ingress where a more numerous, crowded and confused body of the moving objects came at every pulsation, pouring in, *as if from without or beyond the rest, toward*

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the eyes; and plainly thus discovered, not as moving in, *but as emerging into the field of view.* This spot seemed, with two eyes, a little to left of the axes of vision; and from it several streams arose. Query: the termination of the *arteria centralis*, or of one of its large branches?

h.—Looking with but one eye, this point of ingress seems very near the axis of vision; and sometimes there is the appearance to be named in the next paragraph.

i.—Looking to the west, clear sky, soon after sunset; through red glass; some few moving points; but chiefly, in the axis of view, a continual influx of a small stream of very small bead-like objects, faint, but real; seeming to move only into the field, and to disappear almost at once through it; not spreading out in it. This appearance I had noticed first of all with a violet glass; and with violet, red, or blue, it was often repeated. By shifting the eye, the movement could be made to occur apparently upward, or to one side; but it seemed to return usually to the downward course. I distinguished this as the *cascade.* The uniform movement seemed to forbid the supposition that this could be the appearance of the corpuscles in the artery; and hence, its explanation is doubtful.

k.—Upon momentarily closing and opening the eyes, there was an appearance of a *rosette-shaped space*, its centre always in the axis of vision, which distinctly and always showed the complementary color of the glass before the eye at the time. This appeared with all glasses; it showed where the axis of vision pierced the sky at the time; and that the cascade was in this axis, the point of jetting in of corpuscles (*g*) in or very near it. This rosette seemed to me to mark the limits of distinct vision on the retina, the portion most impressed by the color of the medium employed. Having observed it, as now named, I could from that time be less distinctly conscious of it, while looking at the moving objects, or other appearances. Thus, through the cobalt-glass, a yellow central spot was really at all times faintly obvious; through green, a reddish spot of like size, and so on.

l.—With glasses showing the moving points faintly, I often succeeded in bringing them out more distinctly for a little while, by having just previously used those of complementary color.

m.—Looking at midday against light cloud: The cascade, small, but very perfect, flowing up, or down, appeared through the cobalt-glass; more faint, through orange, red, and violet. To see any moving traces of the corpuscles, with yellow or red glasses, it was found necessary to compress the eye-ball, as could be done by making the effort to retract it, and to look into a space very near the eyes.

In regard to the facts mentioned in (*k*), it should be added, the traces of the discs were visible both in and around the cen-

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tral area of the field, or that which showed the faint complementary color. And the arising of this color after a few moments' use of any of the colored media, seemed to show that, over the most sensitive portion of the retina, the tendency to the perception of the secondary subjective color, or that which follows the impression of a previous and different one, is even stronger than the present impression of any given color, so that the subjective complementary can here displace even the actual or acting color!

IV. The singular results which these observations seems to furnish, then, are the following:

aa.—*Quasi*-vision of moving blood-discs; showing, incidentally, also the places and courses of certain capillaries of the retina.

bb.—Discovery of *some change*, in which the momentarily illuminated trace of the disc, in some cases, and usually at a little distance behind the advancing disc, gives way to *black*.

cc.—*Quasi*-vision, in different ways, of the cells or granules in anterior portion of the retina.

dd.—Discovery, by apparent absence of these, of either the entire seat of most distinct, ordinary vision ("yellow spot"); or else, of the place of the insensible spot, magnified. The latter view doubtful.

ee.—Appearance as of numerous, swarming, black points.

ff.—*Quasi-vision* of numerous small bodies, moving close together, and apparently steadily, in unlike directions, but so that the several streams cover nearly the whole field; as if the contents of many capillaries, or venous radicles, close together.

gg.—Obscure perception of finely mottled colors, at the same time with vision of the moving discs.

hh.—*Quasi*-vision of place of influx of a considerable proportion of the discs into the field of view; suggesting the artery, or a large branch of it.

ii.—*Quasi*-vision of single stream, seen only in a brief course through the field, and seemingly without impulsive movement —the *cascade*.

kk.—Perception of nearly circular, or rosette-shaped area, of subjective color, corresponding with the seat of most distinct vision.

ll.—The actual visibility of this subjective (complementary) color, within and in spite of the generally diffused presence of the opposite color at the time.

V. Among principles incidentally discovered or affirmed in course of the discussion, appear to be the following:

aaa.—That the traces of the moving blood-discs are not invariably, nor necessarily, of a color the complementary of that occupying the surrounding retina at the time.

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bbb.—That the blood-corpuscles, single or sparse, as in the retinal capillaries, can transmit, without appreciable diminution of intensity, rays of any color. In this way the coloration of the fine parts of images of pictures, landscapes, etc., on the retina, is not, during our view of the objects, continually interfered with.

ccc.—That moving blood-discs, within the capillaries of the retina, according to their form and position, may affect the light passing through them in various ways, by lens-action or total reflection.

ddd.—That images in the retina are variable in their place, (within the limits constituting, on either hand, myopia or presbyopia), by minute changes of *depth;* and are composed of a series of solid images of as many colors as the light admitted to the eye contains, and more or less perfectly coalescing.

Moreover, as general facts bearing on the explanation of the phenomena now detailed, the following propositions seem to be established:

eee.—That the eye or eyes, in order to discover any of the appearances named, must be *focused* or adjusted for vision of an object at some certain distance. This necessity of focusing the eye explains why, usually, the appearances are so readily lost.

fff.—That this adjustment differs for light of different colors, the implied distance of the object being greater or less. Observations seem to indicate that the distance of the imaginary object is least for the red rays, and less generally for the less refrangible.

ggg.—Hence, when either appearance is seen by merely looking steadily toward a lighted surface, or until the eye is fatigued, it is probable that, involuntarily, the proper focusing or adjustment of the eye takes place.

hhh.—With the single exception, if it be such, of the case of looking steadily at a bright surface, or with the eye fatigued, the light with which any of these phenomena is discovered, is never white or complete light, but always partial, of special colors and refrangibilities.

That is, all the media, or lights, showing these effects, are such as afford rays of not all, but some certain refrangibilities. All these general facts agree with the supposition that the blood-discs become *quasi*-visible by means of their effect as lenses. Although we may not be able to say in what way, *precisely*, each part of the phenomena results, it appears certain that the discs, and in certain other cases the retinal cells, so modify the convergency of rays entering the retina through them, or perhaps in some intances, the divergency of more refrangible rays which have already passed their focus and spread out, (at the very time that red and yellow rays have their focal distance and proper effect),

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that the impression of the retina through many of these bodies must be decidedly different from that which it receives or yields around their place. We may say, generally, that the visible corpuscles or cells become so from the fact that in certain ways and degrees they *complement* the effect already impressed on the light by the crystalline lens and the humors of the eye. This view suggests a ready explanation of the circumstance that media of different colors require a convergency of the optic axes toward points at different degrees distant from the eyes; since we must presume that this is one instance of "associated movements," and one in which, accordingly, the mere telescopic adjustment of the place and convexity of the crystalline lens, will be made to correspond, involuntarily and accurately, as in ordinary vision, with the degree of convergency voluntarily or otherwise given to the optic axes.

The change by which certain of the lucid lines are replaced through a part of their length by black, it is difficult to explain. The effect can hardly be that of the accidental or subjective production of black (total absence of impression), succeeding a previous impression of brightness; for, were it such, it should be more general, and follow through the whole length of the bright line. Assuming each line to be not less than twenty times longer than broad, and nearly as broad as the corpuscle could appear, if seen bodily in its place, then the black portion is seen to follow at some distance behind the advancing corpuscle. Is it due to the collapsing wall of the capillary, or to changes in its liquid contents, such as to result, a little way behind the corpuscle, in certain cases, in a brief *total interference* of transmitted rays?—or, such as to produce along an inconsiderable length of the vessel the effect of *total reflection*, excluding momentarily the light from that part of the retina directly behind its place?

Finally, it needs hardly be said that, in order to observe many of the phenomena now considered, much care and patience will be required, and not less an eye so delicately sensible to color that it can appreciate the finest colored points and very faint tints. And the caution must be added, that experiments of this kind can scarcely be protracted very long at any one time, or repeated continually for weeks or months, with no long intervals of rest, without the risk of permanent injury to the delicate organization of the eye.

New York, Jan. 16th, 1861.

Note:—*March* 15.—Since the above was written, Sir D. Brewster's paper enumerating "Certain Affections of the Retina" (*Philos. Magazine*, Jan. 1861), has appeared, but containing no allusion to vision of the blood-discs. To the list, this, and certain related phenomena quite as singular, it appears, may now be added.

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ART. XXX.—*Upon some Experiments connected with Dove's Theory of Lustre;* by Prof. O. N. ROOD, of Troy.

IN the *Farbenlehre*, p. 177, Prof. Dove writes: "In every case where a surface appears lustrous, there is always a transparent or translucent reflecting stratum of minor intensity, through which we see another body. It is therefore externally reflected light in combination with internally reflected, or dispersed light, whose combined action produces the idea of lustre."

Thus by combining in the stereoscope two projections of a pyramid, one drawn in black lines on a white ground, the other in white lines on black ground, Dove found that the pyramid appeared lustrous as though made of graphite. [To me it recalls rather the idea of highly polished glass.] He found also that a yellow and blue surface when combined in the stereoscope and viewed through a plate of violet glass, produced, in the act of combination, the idea of a polished metal.

Similar to Dove's theory of lustre is that of Prof. Ruete.*

This view of the nature of lustre opens to us the possibility of reproducing by the stereoscopic combination of suitably colored surfaces, the individual lustre and appearance of gold, copper, brass, &c.; it also affords us a means of examining separately the components, which *may produce* the appearances peculiar to each.

1. I combined in the stereoscope on white or on black grounds —a piece of tin-foil one inch square with a piece of yellow paper of the same size. The value of the tint on the chromatic circles of Chevreul was, 1st circle, orange-yellow, No. 4. When the field containing the tin-foil was somewhat shaded by the hand or otherwise, the surface seen in the stereoscope could not be distinguished from gold-leaf. The union of the images took place as readily and the illusion was as strong with persons unaccustomed to the use of the instrument.

2. By combining in the same way tin-foil with orange-tinted paper, (1st circle, orange,) the lustre and appearance of copper is imitated.

3. Tin-foil in the act of combination with Nos. 14 and 15 of the red and black scale imitate bismuth.

4. Tin-foil or silver-foil in the act of combination with ultramarine paper appears scarcely blue, rather black like foliated graphite.

5. Gold-leaf in combination with paper of a tint nearly that of the green of the 1st circle imitated murexide.

6. Gold-leaf in combination with ultramarine paper resembled a surface of graphite.

* *Das Stereoscop;* C. G. Th. Ruete, Leipzig, 1860.

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Upon substituting dark grey paper for the tin-foil the same effects in degree were not produced, owing as it seemed to me, to the fact that the well known texture and appearance of the paper forcing itself on the attention, precluded the idea of anything metallic. To remove this difficulty I employed two means.

1. A crumpled sheet of tin-foil was photographed, and from the negative, prints were taken, by the "ammonia-nitrate process," which were toned to the so-called black of the photographers. This furnished dark paper upon whose surface was an accurate drawing of the irregularities characteristic of metallic foil; the surface of the paper was of course wholly without lustre.

(*a*) Upon combining, in black or white fields, a square inch of one of those photographs, with the above-mentioned yellow paper, and shading the photograph a little, a representation of gold was obtained but little inferior to that given by the use of the real tin-foil.

(*b*) This photographic paper in combination with orange paper (1st circle, orange), made an imitation of metallic copper.

(*c*) The ultramarine paper in combination with the photograph of tin-foil gave a striking imitation of foliated graphite. The blue color is perceived much less than would be expected.

2. The surface of a plate of brass 1 inch square was polished, and then rather heavily scratched by a coarse file. Into the scratches a small amount of yellow or white oil paint was rubbed, and upon this prepared surface dark grey or black paper was laid and the whole submitted to the action of a press as in copper-plate printing. By this means a drawing of a scratched metallic surface was transferred to paper. These markings serve also to enable the observer much more easily to direct his attention simultaneously to the two impressions presented.

(*a*) Upon combining dark grey paper (black and white scale, Nos. 18, 19, 20,) prepared in this way with the above-mentioned yellow paper, the appearance of a polished, scratched plate of gold was obtained.

(*b*) When these dark prepared papers were combined with yellow paper colored by gamboge (yellow and black scale, No. 9), the appearance and lustre of brass was obtained.

According to Dove's theory the darker surface in the stereoscope represents the dispersed light, the brighter, that regularly reflected. As the polish of a metallic surface is proportional to the smallness in amount of the light it disperses, we should be led to expect that by varying the shade of the black paper, we should be able to alter the apparent degree of polish of these imitated metallic surfaces.

This is the case: yellow paper, (1st circle, orange-yellow No. 4,) in combination with black (No. 21,) gives the idea of a very

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highly polished golden surface; as we descend in the scale, the lustre and resemblance to polished metal regularly diminishes till at grey, No. 8, almost no effect like gold is to be perceived.

On the other hand by diminishing the brightness of the yellow paper, the black tint remaining constant, the idea of a polished golden plate in the shade, or so placed as to reflect the image of some dark object, is produced. Thus we may descend through the circles of Chevreul to the 7th, when by combining the orange-yellow of that circle with No. 21 of the grey scale, the idea of a golden plate much shaded is produced. I constructed tables expressing the effects produced by varying the intensity of the two components, but it is not worth while to introduce them here.

As we are accustomed to see gold tinted variously from nearly a yellow as in gold-leaf, to almost a copper-hue as in some specimens of our American coin, so the tint of the paper placed in the stereoscope, may be varied within certain limits, without greatly affecting the results.

Prof. Helmholtz in his admirable work on physiological optics,* mentions that by a peculiar arrangement he was able to cause the homogenious golden yellow light of the spectrum to appear brown, proving thus that the tint brown is only weak yellow light. These stereoscopic experiments give us on the other hand the means of apparently converting brown into a metallic golden yellow, for many specimens of even brown wrapping paper, when combined in the stereoscope with very black prepared paper, acquire the lustre and appearance of yellow plates in the shade, and reflecting images of dark objects.

In the same manner, and corresponding to the investigations of Helmholtz, I found that the stereoscopic union of black glazed paper with red, (No. 14, red and black scale,) imitated with surprising perfection the appearance of a glazed plate of chocolate.

The chromatic scales of Chevreul furnish us with a ready means of combining in rapid succession in the stereoscope a great number of definite tints; thus by cutting in a card-board two parallel apertures $\frac{3}{10}$ inch broad and one inch long, their distance apart being 2·6 inches, and pasting under one of them black prepared paper, the other can be brought over any desired tint and the effect noted.

1. In this way I found that a pretty good representation of the appearance of slightly tarnished lead was produced by the stereoscopic union of grey No. 18 and No. 4 on the blue-violet and black scale.

2. A somewhat inferior imitation of antimony was given by No. 1 blue and black scale, with gray Nos. 18 to 20, or by using No. 17 blue and black scale with white.

* P. 281. *Physiologische Optik* (*Encyklopädie der Physik*, Leipzig, 1860.)

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3. Tarnished zinc surfaces may be imitated by the use of grey No. 5 with No. 18 blue and black scale.

4. Ultramarine paper with some of the lighter violet blues gave an imitation of blue glass. The idea of blue polished glass was also obtained by using in combination with the ultramarine paper No. 1 of the yellow and black scale.

I will mention here that the stereoscopic union of this blue with yellow paper, never induced in my mind the idea of green.

I made some experiments to ascertain how far the *stereoscopic* mixture of two masses of different colored light corresponded to their true mixture by the method of rapid rotation, use being made of the imitations above described. It is however so difficult to compare a varying with a fixed tint that I will not record the results obtained; in many cases a certain moderate amount of agreement in the resultant tints was observed. Brücke found that when a deeply colored yellow glass was held before one eye, a blue cobalt glass before the other, that a landscape viewed through this combination was simply darkened in appearance. I repeated this experiment with similar glasses and obtained a like result; objects appeared darkened, but in their natural colors, though sometimes the blue or yellow tint predominated a little. But when I presented to a *single* eye these two masses of light a very different result was obtained; the plates of glass were attached to a blackened disc opposite suitable perforations, and it was set in rapid rotation; a landscape viewed through it appeared deep purple, though not a trace of this color was to be perceived in the binocular use of these glasses.

When these two glasses were held before the same eye, a landscape viewed through them was very much darkened but scarcely colored.

Sir David Brewster's Theory of Lustre.

Sir David Brewster opposes Dove's theory of lustre, as he has found that when black and white surfaces without drawings are combined in the stereoscope, no lustre is produced. The lustre, then, according to this philosopher is due not to one mass of light passing through another, but to the effort of the eyes to combine the stereoscopic pictures.

Admitting the correctness of Sir David's experiment, Dove has shown that the objection founded on it is without weight—(p. 3, Optical Studies).

In repeating Brewster's experiment I always obtain the *opposite result;* in combining uniform black and white surfaces, without drawings, I always obtain a distinct impression of lustre, like that of the blackened mirror of a polariscope, and in strict accordance with Dove's theory, when the black field is so darkened that *no light* is sent from it to the eye, this lustre vanishes,

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and the white paper alone is perceived. This disagreement is not a cause of astonishment when we reflect that de Haldat's original experiment waited nearly half a century for confirmation.

To Brewster's own theory, the simple objection, which has already been made by others, that we daily perceive lustre plainly with one eye, would seem sufficient.

Production of Lustre in Monocular Vision.

I proceed now to describe some experiments where by the action upon a single eye of two masses of light of unequal intensity, the idea of lustre is produced.

1. If a disc of colored card-board, out of which a number of sectors has been removed, be made to rotate rapidly, and an object be viewed through it by a single eye, two masses of light will reach the eye, which apparently proceed from the object; one is reflected from the surface of the disc, the other emanates from the object behind the disc, and passes through the first mass of light. Dark objects viewed in this way assume to me to a small extent an appearance like that of blackened glass. The effect is not at all striking, and would be overlooked by many persons; I therefore prepared paper in a peculiar way so as to imitate distantly the appearance of foliated graphite or crumpled mica.

White smooth drawing paper was rubbed over irregularly with a brush *slightly* moistened with a weak wash of India ink or lampblack; when dry another wash of a deeper hue applied as before, care being taken to leave many small spots untouched. The final wash was laid on with pure black. If the brush be kept nearly dry and passed only lightly over the paper, it is easy to obtain a surface bearing some very distant resemblance to the minerals above mentioned; it is of course without lustre. Similar papers were prepared with red and blue water colors.

When these papers were held behind discs of ultramarine or orange-tinted paper, from which equal alternate sectors had been removed, and which were revolving at such rates that their surfaces seemed uniform, or at lower rates, they often appeared, to a single eye, highly lustrous. This was true of the prepared paper in a *state of rest;* when moved slightly by the hand it glittered strongly. Dark photographs of tin foil held behind a revolving disc of ultramarine paper and viewed by a single eye, assume often to a striking degree the lustre and appearance of foliated graphite.

2. If a piece of this peculiarly blackened paper $\frac{1}{2}$ of an inch square be placed in a blue field, (rather light ultramarine paper,) and be steadily regarded for some minutes by one eye it assumes a red orange-hue and appears suspended over the blue paper

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and nearer to the eye than the latter; at the same instant it appears lustrous like crumpled mica. The illusion with me often lasts half a minute in great perfection; this is particularly the case when the eye is not quite accurately focused on the paper.

3. If a sheet of this prepared paper be brightly illuminated by light from a window, and be held so near one eye as to produce indistinct vision, it often apparently becomes highly lustrous. In this case enlarged images of the white and grey points are formed on the retina which overlap, so that again we have two masses of light, one passing through the other.

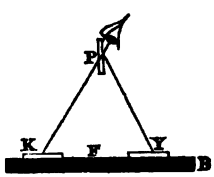
4. If a *roll* of black paper like the above, but coarser in its markings, be brightly illuminated on one side and viewed through deeply colored plates of glass (red, green, blue,) in a few seconds it appears lustrous resembling a roll of polished zinc which has been irregularly and deeply corroded by an acid. Upon removing the glass the surface of the paper appears lustrous for an instant.

5. A sheet of the finer variety of this prepared paper viewed through a large rhomb of calc spar gives often in spots the appearance of lustre, particularly when the head of the observer, or the rhomb, is slightly moved. Some persons compared this to the appearance of water.

It would seem probable that in all cases where two masses of light reach a single eye, one passing through the other, particularly when there is any *perception of their individuality*, that the appearance of more or less lustre is produced, though from habit we often overlook it. Thus Helmholtz remarks* upon the combination of two colored surfaces in monocular vision by means of a simple instrument he figures:—"It is particularly favorable when the drawings, or spots on the two surfaces are made to shift their position. Then we often believe that we see both colors simultaneously in the same place, the one through the other. We have an impression in such cases of seeing objects through a colored vail or reflected from a colored surface."

I found in fact that by placing stereographs consisting of colored paper for one eye and a photographic drawing of tin-foil for the other in this instrument, that lustre could be perceived, particularly with the imitations of copper.

The diagram represents the instrument referred to; it consists of a plate of glass, P, with parallel sides, which is properly supported over a blackened board B. Differently colored papers are placed at K and Y; one is seen through the plate, and the other by reflexion from it. The images are made to overlap and their intensity is regulated by altering their distance from F.



* *Physiologische Optik*, p. 273.

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Analogous to this is the observation of Brewster.* Speaking of uniting similar pictures, (patterns on hanging paper,) in binocular vision, he remarks:—"The surface of it, (the wall) seems slightly curved. It has a *silvery transparent aspect.*" Here the images though of the same intensity, &c., moving with each slight movement of the head induces in the mind the idea of one object seen through another.

In closing I will remark that while many of the experiments above mentioned are easily repeated, others require considerable practice in this kind of observation.

ART. XXXI.—*The Quaternian or Diluvian Period, considered in its relation to the present Epoch;* by F. J. PICTET.

[From the Bibliothèque Universelle (Archives) de Genève, vol, viii, p. 255.]

WHEN in 1844, the first volume (1st edition,) of my elementary treatise on palæontology was printed, I was struck with the impossibility of fixing a precise limit between the Diluvian epoch and the present or modern period. These two periods, it is true, have been considered as distinct in all treatises upon geology; but when I attempted to point out their palæontologic characters, I soon perceived that the zoologic population had not in reality been modified in passing from one to the other, and that they are evidently the uninterrupted continuation of one and the same state of things. This truth appeared to me so evident that I merely indicated the principal arguments which supported it,† without entering into details, and I considered it sufficient, to call the attention of geologists and palæontologists to this point. This has had its influence, and recently, since questions of this nature have taken a new importance by the discoveries relating to human fossils, many geologists have admitted the above conclusions as demonstrated. I would especially mention Mr. Scipio Gras,‡ who is engaged in an important work on the diluvium of the valleys of the Rhone and the Rhine, and also Mr. Lartet,§ who has recently sustained the same opinion in a memoir upon the geological antiquity of the human race in western Europe.

There are however some opponents to these views, especially Mr. Kœchlin Schlumberger,‖ who replying to Mr. Scipio Gras, has called my opinion *a little radical* and has sought to overthrow

* The Stereoscope, p. 91, London, 1856.

† *Traité élémentaire de paléontologie*, note B, 1st edition, tome i, p. 359.

‡ *Bulletin de la Société géologique de France*, 2d Series, tome xv, p. 167.

§ *Bibl. Univ.* (*Archives*), tome viii, p. 193. July, 1860.

‖ *Bulletin de la Société géologique de France*, 2d Series, tome xvi, p. 88. Nov. 21, 18.9.

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it. I therefore think it necessary at this time to furnish new proofs and to set forth more clearly those evidences which have decided my own mind, and which I have no doubt will convince the most incredulous.

This question may be considered from two points of view, the geological and the palæontological. I shall only approach the question in the latter aspect, for which my studies have better fitted me, but I ought to remark that we have no example of serious disagreement between palæontology and geology when they are employed to distinguish the several periods of the history of the globe. There is no one of these periods which is not clearly distinguished by the character of its fauna, and no case can be cited where stratigraphy has required a division which palæontology has not confirmed. If we survey the whole series we never find any two consecutive stages in which the zoological population has been identical.

If this is so, the geologists and the palæontologists will be unanimous for uniting these two epochs into one, and for applying to them a common name. I think if I am able to prove, from the standpoint of palæontology, that the two periods are only one, this result ought to be as fully admitted as in analagous cases for anterior epochs.

I know that this opinion is not without question, and that some geologists, whose learning and judgment I highly respect, think that in the condition of the globe and the forces which have existed since the termination of the tertiary period there are sufficient reasons for distinguishing completely the tertiary period from the modern epoch. I shall not discuss this question for which I do not think myself qualified. I will only say that however this may be, it will be impossible for me to assimilate the separation of two periods whose fauna are continued identical from one to the other, to the well determined limits which distinguish geologically and palæontologically all the anterior periods admitted as divisions of the history of the globe. I have elsewhere intimated that these same geologists are singularly embarrassed in regard to the precise point where they ought to establish the division, and that the long series of Quaternary deposits, following the glacial period, which certainly neither commenced nor ends suddenly, will give them very great difficulties.

My object in this communication is simply to demonstrate that between the Diluvian period and the modern epoch there has not been any modification of the fauna having the least relation to the changes which characterize and distinguish other palæontological faunæ. For this purpose I shall consider two distinct points. I shall demonstrate first that *all* actual or modern faunæ have existed from the origin of the Diluvian period. I shall

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inquire afterwards what differences exist between the Diluvian fauna and the present fauna and shall show that they consist only in the disappearance of a limited number of the larger species.

I ought however before proceeding to details to notice an objection. Of late years questions relating to the origin of species have been reviewed with renewed ardor, and some persons think that the solution of these questions may have an influence upon the demonstration of the question with which I am now engaged. On the contrary I think the subject with which I am concerned is entirely an independent question. Whether we admit with Lamark or with Mr. Darwin a gradual transformation of beings, or think there is a general law of nature introducing, at certain epochs, new organic forms, or accept the idea of successive creations, we shall in either case be obliged to refer to the same facts in the history of the globe. At the end of a certain number of years or centuries the zoological population of a country is changed and the species are replaced by others. The surface of the globe has been successively occupied by a series of faunæ perfectly distinct; each of these fauna corresponds to a period which it characterizes. Whatever theory may be entertained in regard to the cause of the change, the change itself is not questioned. But all we need to do here, is to show that these organic differences characterize the successive periods, and that there is no such difference between the Diluvian period and the present epoch.

I ought, as I have said, to demonstrate in the first place that all the present faunæ have existed from the commencement of the diluvian period, as well as the last species, of which I shall speak farther on. For this purpose I have recently arranged a complete catalogue of the fauna of European mammifers, and I have inquired which have not been found in the fossil state, and what are those the bones of which have been found buried in the Quaternian or Diluvian beds, with the fossil elephant, *Elephas primigenius* or with the Cavern Bear, *Ursus spelæus*.

Reasoning upon comparable and sufficiently certain facts, I have excluded from this list:

1st, Marine mammifers in view of the difficulty of determining the age of marine Quaternian deposits.

2d, Mammifers of remote regions whose bones are not likely to be found in the more explored and better known diluvian deposits of Central Europe. Thus I have not considered as important either the monkey of Gibraltar, or the small species on the confines of Asiatic Russia, or those which have been recently discovered in Sicily or in Turkey. I have confined myself to those actually living in places where the Quaternian deposits are well known. Besides this, the excellent work of Eichwald

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proves the existence of the same state of things in Russia as in England, Belgium, France, Germany or Switzerland.

The following are the principal facts obtained from an analysis of my catalogue, viz:

Almost all the common species of *Cheiroptera* have been found in the Quaternary deposits. I have found, especially those here cited: *Vespertilio*:—*V. noctula*, *V. pipistrellus*, *V. serotinus*, the *common bat*, the lop eared bat, *Vesp. auritus*, the *fer à cheval*, the *V. discolor*, and the *V. mystacinus*. Is it not extremely probable, not to say evident, that the rare species more recently discovered which are wanting upon this list, are wanting because we have not known how to distinguish their bones or because they have not *yet* been found? What geologist will venture to affirm that, the varieties *V. Leisleri*, *V. Kuhlii*, &c., which only appeared before the species named above, appertain to a more recent fauna.

The same results are furnished by the *Insectivora*.

In these same Quaternary deposits are cited the hedge-hog, the mole and three or four species of the shrew-mouse.

This is all our fauna, for, on account of the reasons mentioned above, I am not able to give any importance to the two species of *Mygale* ('*desmans*'), one from the Pyrenees and the other from Russia, which have not yet been found in the fossil state.

The group *Rodentia* is of difficult determination and we may naturally expect to find some vacancies, but there are none, however, of any importance. We may cite the squirrel, the marmot, the dormouse, the mouse, the hamster (*Crisetus*), the water-rat, the ordinary meadow-mouse, the beaver, the hare, and the rabbit. The only striking vacancy will be that of the porcupine, but Mr. Arcas has fortunately found this also in the caverns of Sicily. There are wanting to our list only some small species of the mouse, the garden dormouse, the muscardin, &c., in regard to which we may make the same reflection, as was suggested by the Cheiroptera. The jerboa, lagomys, &c., are found as fossils in Russia.

The *Carnivora* being in general larger than those animals which represent the preceding groups and being at the same time more easily recognized scarcely present any vacuity.

There have been found the lion, cat, wolf, domestic dog, fox, genet, white bear, brown bear, badger, glutton, martin, beech martin, polecat, ermine, weasel and the otter. There is lacking to this list only the lynx, and it is important to know whether the *Felis engiholensis* of Schmerling, from the caverns of Belgium is not identical with it. I have not supposed that any person could see an indication of a subsequent creation in the absence of some species from excentric regions as the fox of the north, the polecat of Poland, or the *P. boccamela* of the Mediterranean islands.

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The only *Pachyderms* of the present fauna yet found in our Quaternary deposits are three, the wild boar, the horse and the ass.

Among *Ruminants* have been enumerated all our present deer, the deer properly so-called, the reindeer, the moose deer, and the roe-buck. The fallow deer is not comprised in this last, but, as is well known, it is not native in Central Europe. There are enumerated also the wild oxen, (the urus and the bison), the chamois, and the goat. The sheep had not been discovered until the last few years, which had probably been more recently imported; however, Mr. Arcas has found in the caverns of Sicily a closely related species, the *mufflon*. Finally, to this series of animals, modern discoveries authorize us to add *man*. All this, as I have said elsewhere,* appears to demonstrate that man has coëxisted with this diluvian fauna and that his history dates probably from the same epoch.

The facts here mentioned are remarkably conclusive, for they prove that all the present fauna of European mammifers have been found as fossils in the Quaternary deposits, except some small species difficult to be determined, the bones of which if preserved, have not yet been recovered. It appears to me evident that these rare exceptions are without value as objections, and that we may boldly declare that: *From the commencement of the Diluvian period to the present day, no species of mammifers has been added to the fauna which then lived in Europe.*

What we have said of mammifers may also be affirmed of birds and reptiles; but upon this part of the subject I shall not enter into details, for these classes are less known and do not furnish results so certain. The examination of a treatise on palæontology is sufficient to show that the existing species are already indicated in the Diluvian deposits.

The terrestrial and fluviatile mollusks are in the same category. Thus with the bones of the *Elephas primigenius* are frequently found buried all our species of Helix, Bulimus, &c., and they show us that for the invertebrata as well as for the vertebrata, all the existing fauna date from the origin of the Diluvian period.

The preceding facts suffice to show that there has been no renewal of the fauna between the Diluvian period and the Modern epoch. We must now consider in what consists the apparent difference which has led most geologists into error. It has been caused by the gradual disappearance of a certain number of species. At the commencement of the Diluvian period the fauna was richer and more complete than it is at present. There lived in Europe at that time not only our present animals but a certain number of species which are now extinct. These latter have gradually disappeared from causes probably in part similar to

* *Bibl. Univ.* (new series), tome vii, p. 364. March, 1860.

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those which destroyed one species of ox mentioned by Julius Cæsar, and which destroyed most likely the last representatives of the ure-ox (aurochs) and the elk. The fauna of the eastern continent has been successively impoverished, and as the population and cultivation of the soil increased only a part of the species which once dwelt there remain living.

It is not possible, in the present state of palæontology to prepare a complete and precise catalogue of these extinct species; but it is sufficient for our purpose to sketch the principal features of such a catalogue.

I am embarrassed in regard to the Alluvial deposits of Auvergne, which appear to present characters somewhat exceptional. It is not perfectly demonstrated that the fauna which they enclose has all been contemporaneous with the Quaternary deposits of the greater part of Europe. There are found many species as yet imperfectly known which appear to be extinct and which have not been recovered elsewhere. Such is the *Erinaceus major*, many of the dogs, some polecats, at least three species of deer, the wild goats of Roset, &c. It will probably be necessary to add to them hereafter; but new investigations appear indispensable to make the proper additions with certainty. I have experienced some doubt in regard to many races or species of true Quaternary deposits, indicated as different from those now living, but which have been characterized without doubt by their form and not by appreciable organic characters. It appears to me quite natural that species at the commencement of the Diluvian epoch, finding abundant nourishment in a country where great forests and immense virgin territories replaced our present culture, and being able there to develop in freedom should have frequently had a form a little superior to their existing representatives, which, surrounded by hunters, restrained on every side, lead a more difficult and precarious life. I do not think it possible to give a specific value to slight differences of stature, if all the other characters are identical, and therefore I consider as doubtful many of those species inserted in the catalogues of palæontology. Such are the *Talpa fossilis*, the *Meles Morreni*, the *Lutra antiqua*, the *Sciurus priscus*, the *Arctomys primigenia*, the *Myoxus fossilis*, the *Sus priscus*, &c. Some of these are probably identical with living species. By new researches we shall find that some of these are truly extinct.

But aside from these difficulties and doubts a certain number of species have certainly disappeared which I will briefly enumerate.

In the family of *bears* I consider as lost the great Cavern Bear (*Ursus spelæus*). Their bones characterize well the deposits called Diluvian, or the formations more ancient than the last period of our globe. The *Ursus priscus* is more doubtful

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and is probably identical with our black bear. The *Hyenas* appear to have been represented in the ancient epochs by three species which have now disappeared; the hyena of caverns (*H. spelæa*), analogous to the spotted hyena of the Cape of Good Hope, the *Hyena Monspessulana*, of Christol, more similar to the striped hyena, and the *Hyena intermedia*, Marcel de Serres.

In the family of the *felinidæ*, we should add to the wild-cat, the lynx (?) and lion which have disappeared from Europe in the historic period, another species related to the leopard, (*Felis antiqua*).

The numerous order of *Rodents* appear to contain some extinct species more different from the living than those which I have cited above in speaking of differences of form. These are the *Spermophilus superciliosus* of Kaup; the Castor (*Trogontherium*) *Cuviere*, Fischer de Waldheim; the *Lepus priscus* Cuvier, from the breccias of the Mediterranean, and some species of *Lagomys*, &c.

The *Elephant* is one of the most remarkable of the genera among those which have made a part of the ancient fauna of our period. Their bones are, with those of the bear, the most characteristic of these Diluvian strata, since they are abundantly scattered over an immense surface of country. The species best known is the mammoth (*Elephas primigenius*). Of other bones may be mentioned those of the African elephant (*E. Africanus*). The existence of some other species (such as the *E. meridionalis* Nesti), is contested by some anatomists and admitted by others.

The great *Rhinoceros* with valved nostrils (*R. tichorhinus*) less widely diffused than the elephant, and probably also one or two species of the same genus, are striking examples of those races which have disappeared.

It is the same with the *Hippopotami* of which it is thought we may admit the prior existence of many species now extinct (*H. major*, *H. minor*, *H. Pentlandi*, and the hippopotamus of the valley of the river Sômme).

The horse of Pézenas appears to be another species different from the one mentioned above as related to the existing horse.

The genus *Cervus* has been numerous from the commencement of the diluvian epoch, for to the species now living, and which, as I have said, existed then, is to be added the beautiful giant stag of the peat bogs of Ireland (*Cervus euryceros*), the great deer of the Sômme (*Cervus dama giganteus*) the *Cervus martialis*, Gravais, and many species from caverns described by Marcel de Serres.

Among the other species of *ruminants* lost from our fauna, it is necessary to mention the *Antelope Christoli*, M. de Serres, the *Dichotoma*, Gervais, and *Ibex Cebennarum*, Gervais.

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I will not add the *Bos primigenius* because it was seen alive by Julius Cæsar.

I have not found among birds or reptiles any species to add with certainty to this list.

We shall find only a few in this category among the terrestrial invertebrata. The marine deposits on the borders of the Mediterranean contain some mollusks of lost species, but their numbers are small compared with species still living.

We thus see, as I have said, that the fauna originating at the period which succeeded the Tertiary epoch has been successively deprived of many remarkable species. This gradual disappearance may have proceeded from many natural causes. First the climate, cooling very much as the formation of great glaciers proves (Glacial period), would not be favorable to any one of them, especially to the great pachyderms, the congeners of which characterize in our day the torrid zone. Still more as I have said elsewhere,* admitting the presence of man from the origin of the latter period, we may, with much probability attribute to him the destruction of a part of the species. If we examine the list which I have given we shall see that, aside from the great pachyderms, it is principally composed of carnivorous animals which man is interested to destroy, and of herbivora which should serve for his nourishment.

Mr. Lartet, in the memoir which I have cited, has furnished a new argument in favor of this hypothesis. He has found marks of the instruments of man upon the bones of many species of this epoch, and in particular upon those of the ox and the goat; these marks being generally deep cuts designed to cause the rupture of the bone, sometimes more superficial wounds as if the object had been to elevate the skin about the base of the horns. This destruction of species is merely like that which daily transpires before our eyes. If new circumstances should cause the laws in regard to the chase to be abolished, and if the great land-owners did not protect some species, it would not be long before all our present deer would be classed among extinct species. They have already disappeared from many countries, and among others from the valley of the Rhone, where the stag and the roe-buck were abundant at the end of the last century.

A curious fact has been cited which seems to confirm what I have said, it is the very limited number of species of small size, or little connected with the wants of man, among those which have disappeared.

Such is the opinion which has been formed in regard to the causes of this extinction. I repeat therefore that these causes can

* *Bibl. Univ.* (new series), tome vii, p. 371, March, 1860.

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have no relation to those which acted during the previous periods, for in the renovation of the fauna there has always been a replacing of some species by others.

Here, on the contrary, we merely find extinctions which can no more furnish a basis for distinguishing two periods than could the destruction of the *Bos primigenius* or that of the Dodo.

To complete our knowledge of the history of the Diluvio-modern period, it would be very interesting to ascertain the date of the extinction of each species. Some investigations of this kind have been recently undertaken, principally in England; but observers generally content themselves with stating the relation of bones to the Quaternary epoch without other details. It is important always where it is possible to determine accurately the position and the geological relations of the stratum which encloses them, and sometimes even to indicate whether they are found in the upper or the lower part of the stratum. It is important to examine with great care the bones in the deposits of the glacial epoch, for it is very probable that many species have extended even to that period. By such studies well directed we may obtain more accurate knowledge of this series of extinctions, and I doubt not we shall be more and more convinced that they have been gradual and successive.

Art. XXXII.—*On the Presence of Phosphoric Acid in Igneous Rocks;* by James Schiel.

Descending from the Sierra Nevada into the plains of the Sacramento river by the route which leads along Black Bute, we meet west of the Bute with a phosphoritic trachyte crumbling into pieces and covering the surface for many miles. As there is hardly a trace of organic substance to be discovered in the soil from which a luxuriant vegetation is springing, it was to be expected that the rock contained phosphoric acid.* This an analysis showed to be the case. The phosphoric acid is contained in the precipitate obtained by ammonia after a pulverized portion of the rock has been disintegrated by fluohydric acid, heated and dissolved in chlorhydric acid. The washed precipitate is dissolved in a small quantity of hot chlorhydric acid, much tartaric acid and some sulphate of magnesia added, and then the phosphoric acid precipitated with an excess of ammonia; the crystals of the phosphate are forming immediately. The amount of phosphoric acid contained in the rock was thus found to be 0·26 per cent corresponding to 0·78 per cent of phosphate of lime.

* Fownes (*Prize Essay*, 1845) demonstrated the general presence of phosphoric acid in crystalline rocks.—Eds.

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ART. XXXIII.—*Ninth Supplement to Dana's Mineralogy;* by GEO. J. BRUSH, Professor of Metallurgy in Yale College.

List of Works, etc.

C. F. RAMMELSBERG: Handbuch der Mineralchemie. 8vo, pp. 1039. Leipzig, 1860.—This work is by no means merely a new edition of Rammelsberg's former "Handwörterbuch des chemischen Theils der Mineralogie." It is entirely rewritten and rearranged, and, as its title indicates, it aims to give the complete history of the chemical properties of each mineral species. It has seventy pages of introductory matter upon the analyses of minerals—the calculation of analyses—a discussion on the value of analyses—the chemical constitution of minerals, including the function of water—heteromorphism, isomorphism, homœomorphism, etc. The whole is arranged according to a convenient chemical classification.

Rammelsberg has done more to give precision to our knowledge of the chemistry of minerals than any other chemist since the time of Berzelius. The present work is one of great value to the mineralogist, the grandest work of the kind ever published—still on careful examination, we are sorry to observe evidences of haste, if not carelessness, in its preparation. It is to be regretted in such a standard book—as this is sure to become—that the author had not given it a little more time and care. This is particularly to be noticed in regard to American minerals:—on page 6 we are told that the native copper of Lake Superior contains 7·29 pr. ct. of silver and 0·03 of mercury; admitting that the specimen examined by Hautefeuille may have contained both silver and mercury, it is unnecessary to offer evidence to the contrary in regard to the thousands of tons which are yearly produced from this region, as shown by the careful investigations of Whitney, Jackson and others.

In many cases where an analyst has made several analyses of one mineral, the author gives the mean result only; this might be well enough, were it not that he very often omits to mention the fact, and compares the results of an extended and careful research, with a single and frequently imperfect analysis, a procedure which certainly has a tendency to create error, and mislead the student who places implicit reliance in this work. Thus, under Danburite, p. 770, examined by Shepard, Erni, and Smith & Brush, we find one analysis by Shepard, one by Erni, and one by Smith & Brush. The natural inference is, that but one analysis was made by each of the two first named, and one by Smith & Brush—had such been the case perhaps Rammelsberg might have been justified in his remark, "that with such differences in results, the nature (composition) of the

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mineral remained in doubt." But how does the case stand—and we may be allowed here to remark that there is no doubt as to the identity of the mineral examined by Shepard, Erni, and Smith & Brush; Prof. Shepard recognizes the mineral examined by us as Danburite, and the writer furnished Dr. Erni the specimens on which his analysis was made.—Shepard's analysis gives 5·12 of alkalies and no boric acid, Erni found 14·13 p. c. of alkalies and 10·04 boric acid. Smith and Brush published two complete analyses, and besides showed by direct experiment that the mineral contains no alkalies (this Journal, [2], xvi, 365). No allusion is made to this latter fact in the work before us, but from the simple composition of the mineral, the experiments must be admitted as conclusive in proving the absence of alkalies, and no further discussion of the first two analyses is needed. Other instances of this kind of omission are found under Carrolite, p. 111, Anal. 2 being the mean of three—Cuban, p. 118, Smith's results are overlooked—Hydromagnesite, p. 233, Anal. 2, is the mean of two, four analyses were published—Jenkinsite, the analysis given is the mean of two—Pinite, p. 835, Anal. 7, is the mean of three—Euphyllite, p. 845, the earlier analysis by Crooke is given, while those of Erni and Garret are omitted; Smith and Brush made four analyses of two different varieties finding some 8 pr. ct. of alkalies which had been overlooked by Garrett, Erni and Crooke, one variety analyzed was from the identical specimen examined by Erni and Crooke—Enceladite, p. 888, an early analysis by Hunt is given; Rammelsberg does not seem to be aware that Warwickite and Enceladite are not only identical, but they are the same mineral from the same locality, both containing boric acid.

Rammelsberg proposes to apply the name GIBBSITE to the phosphate of indefinite composition examined by Hermann, notwithstanding this name was first applied by Torrey to a pure *hydrate of alumina*, and the results of the latter have been confirmed by four other chemists. The author gives as his reason, that Silliman, and Smith & Brush found a small amount (0·57–0·67 pr. ct.) of phosphoric acid, consequently showing the presence of a mixture of phosphate and hydrate of alumina. We add, that if this be admitted, the reasoning applies with much more force to the Russian *Hydrargillite* in which Hermann found 1·43 per cent phosphoric acid! The mineral described by Dr. Torrey is a native hydrate of alumina, and Gibbsite having many years precedence, there is no reason for arbitrarily replacing it by the name Hydrargillite. It matters not what Hermann analyzed, it is an indisputable fact that Torrey's Gibbsite is hydrate of alumina, and furthermore such a change of names as our author proposes, is against all usage, and followed out would cause endless confusion in nomenclature. We have

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noticed only points in regard to American species; other examples might be quoted to justify our assertion that the work, although of great value, is marred with evidences of haste in its compilation, but we would not overlook the great services its illustrious author has rendered to the science of Mineralogy, of which no better evidence could be quoted than the work we have before us.

Dr. ERNST WEISS: Ueber die krystallographische Entwickelung des Quarzsystems. 4to, pp. 102. Halle, 1860.

ALBRECHT SCHRAUF: Ueber die Krystallformen des Kieselzinkerzes. 8vo, pp. 27, mit 6 Tafeln. Wien, 1860.

ALBRECHT SCHRAUF: Krystallographisch-optische Untersuchungen über die Identität des Wolnyn mit Schwerspath. 8vo, pp. 15, mit 8 Tafeln. Wien, 1860.

H. DAUBER: Ermittelung krystallographischer Constanten und des Grades ihrer Zuverlässigkeit (21. Akanthit). 8vo, pp. 18, mit 5 Tafeln.

C. F. RAMMELSBERG: Ueber Isomorphie und Heteromorphie bei den Singulosilikaten von Monoxyden und Sesquioxyden. Pogg. Ann., cix, 584–94.

J. REINHARD BLUM: Handbuch der Lithologie oder Gesteinlehre. 8vo, pp. 356, mit 50 Figuren. Erlangen, 1860.

W. H. MILLER: Crystallographic Notices, containing observations on the Employment of the Stereographic Projection of the Sphere in Crystallography; on the Measure of the Dihedral Angles of Crystals; on the Cleavages of Rutile; on the doubly-refractive character of Thermophyllite. (*L. E. and D. Phil. Mag.*, [4], xix, 325).

J. P. COOKE: Crystalline Form not necessarily an indication of definite chemical composition; or on the possible Variation of the Constitution of mineral Species independent of the Phenomena of Isomorphism. (*L. E. and D. Phil. Mag.*, [4], xxi, 406, and *this Journal*, xxx, 194.)

E. SÖCHTING: Die Einschlüsse von Mineralien in krystallisirten Mineralien, nebst Betrachtungen über die Entstehung von Mineralien und Gebirgsarten. 8vo, pp. 357. Freiberg, 1860.

DES CLOIZEAUX ET DAMOUR: Examen des propriétés optiques et pyrogénétiques des mineraux connus sous les noms de Gadolinites, Allanites, Orthites, Euxenite, Tyrite, Yttrotantalite et Fergusonite. Ann. de Chim. et de Phys., [3], lix, 357.

A. DELESSE: Recherches sur les Pseudomorphoses, pp. 76. (Extrait des Annales des Mines, xvi, 1860.)

AQUILLA SMITH: A new Pyrognostic Arrangement of the Simple Minerals hitherto found in Ireland. (*Dublin Quar. Jour. Sci.*, No. 1, Jan. 1861.

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E. J. CHAPMAN: A popular exposition of the Minerals and Geology of Canada. Under this title, Prof. Chapman has contributed a series of interesting articles to the Canadian Journal of Industry, Science and Art.

A. KENNGOTT: Uebersicht der Resultate Mineralogischer Forschungen in Jahre 1859. 8vo, pp. 212. Leipzig, 1860.—A complete review of the Mineralogical Researches published in 1859, with additional observations and critical notes by Prof. Kenngott.

H. KOPP UND H. WILL: Jahresbericht über die Fortschritte der Chemie, und verwandter Theile anderer Wissenschaften, für 1859. Giessen, 1860. 8vo, pp. 903.—Pages 765 to 820 contain Prof. Kopp's excellent review of the progress of Mineralogy for 1859.

R. HERMANN: Heteromeres Mineral-Systems. (Zweite umgearbeitete Auflage). 4to, pp. 214. Leipzig, 1860.

V. v. ZEPHAROVICH: Ueber die Krystallformen des Epidot. 8vo, pp. 22, mit 2 Tafeln. Wien, 1860.

Descriptions of Species.

ACMITE.—For a memoir on the crystalline form of this mineral by vom Rath, see *Pogg. Ann.*, cxi, 254.

ALBITE [p. 240, VI, VIII].—An interesting variety of albite occurs associated with smoky quartz at Moriah in Essex County, New York. It has a greenish color and a peculiar lustre resembling green diallage. Cleavage very perfect, showing with great distinctness the triclinic striations. G.=2·633 (Brush). Analysis by Mr. Edward H. Twining, Assistant in the Laboratory of the Yale Scientific School:

Si	Al	Fe	Ca	Mg	Na	K	Ign.
67·01	19·42	0·95	0·39	*tr.*	11·47	0·25	0·24=99·73

ARGENTITE [II].—Kenngott considers the mineral from Copiapo described by W. J. Taylor as *stromeyerite* (Suppl. VIII) to be a cupreous variety of *argentite;* excluding the iron found in the analysis as FeS_2 the remaining sulphids of silver and copper are in the proportions of 4AgS to 1CuS (Kenngott, *Uebersicht*, 1859, 115). For a memoir on the crystalline form of *argentite* see Dauber in Ber. Wien. Akad., xxxix, 685. Dauber describes a new locality of this mineral at the Himmelfurst Mine near Freiberg. Sp. gr. of Freiberg specimens 7·192—7·199, from Joachimsthal 7·246. At Freiberg it is associated with argentite and stephanite. Analyses of *argentite* by P. Weselsky show it to be identical in chemical composition with argentite. Specimens from Freiberg contained 86·71 silver, 12·70 sulphur; from Joachimsthal, 87·4 silver. AgS requires by theory 87·03 Ag, and 12·97 S.—*Ber. Wien Akad.*, in *Jour. prakt. Chem.*, lxxx, 487.)

ALUMINITE [p. 389, II].—Analyses of *aluminite* by Geist (1) and Dieck (2) from the vicinity of Halle show, according to Heintz, that the specimens may be mixtures of different basic sulphates of alumina, (Kopp, *Jahresbericht*, 1859, 811):

	S	Al	Si	Fe	Ca	Mg	H	
1.	22·18	39·86	1·92	0·40	0·50	0·03	34·91[a]	=100·00
2.	15·56	36·54	——	——	——	——	46·89	= 98·99

(*a*) by the difference.

AMMIOLITE [p. 142, II].—F. Field has published (*Quar. Jour. Chem. Soc.*, xii, 27) an extended examination of a *red mercurial mineral* occurring with mercurial tetrahedrite, atacamite, malachite, azurite, limonite, and silicate of manganese and copper at Tambillos near Coquimbo in Chile. It differs materially from the *ammiolite* de-

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scribed by Domeykô, especially in regard to the action exerted upon it by acids; still Field considers that it is only a variety of the mineral, derived from the oxydation of a mercurial tetrahedrite. Purified by prolonged digestion in nitric acid, the red powder was found to contain in two different specimens:

	Hg	Sb	S	Fe	H	Si
1.	34·42	14·21	5·43	2·68	4·46	35·50 = 96·70
2.	37·94	15·26	5·98	2·94	4·98	29·78 = 96·80

Dividing the sulphur equally between the mercury and antimony, making the former a simple and the latter a tersulphid, and oxydizing the remainder of each metal, then considering the silica and oxyd of iron as accidental impurities, and deducting the water, we have, according to Field's figures:

	HgO	HgS	SbO_3	SbS_3
I.	31·77	35·53	15·61	16·52 = 99·43
II.	33·36	34·83	14·92	16·77 = 99·88
Mean,	32·56	35·18	15·27	16·64 = 99·65

Field considers that this composition may be represented as a tribasic sulphantimonite of mercury combined with tribasic antimonite of the same metal ($3HgS, SbS_3$) +($3HgO, SbO_3$) equivalent to HgO 32·93, HgS 35·37, SbO_3 17·07, SbS_3 14·63= 100. Or, he suggests further, it may be regarded as an oxysulphid of mercury coupled with an oxysulphid of antimony with the formula $3(2HgO, HgS)+(2SbS_3, SbO_3)$, giving the same percentage and composition. [We do not clearly see the relation between these two formulas, in the first we have three atoms each of HgS and HgO, and one atom each of SbO_3 and SbS_3, and in the second formula 6HgO, 3HgS, $2SbS_3$, and one atom SbO_3. It is evidently impossible for these formulas to give the same percentage composition.—G. J. B.]

Apatite [p. 396, I—VIII].—H. Reinsch has found in the phosphorite of Amberg not only chlorine, fluorine, and iodine, but also bromine.—(Kopp, *Jahresbericht*, 1859, 805.)

Bamlite.—See under *Sillimanite*.

Batrachite.—See *Monticellite*.

Beryl [p. 178, II—V].—Analyses of *beryl* by Hofmeister, (1 and 2) Rosenbach in Silesia, (3) Heubachthale:

		Si	Al	Be	Fe	Ca	Mg
1.	G.=2·65	65·34	21·01	11·32	1·21	0·26	0·12
2.	G.=2·65	65·69	20·41	11·60	1·45	0·20	0·11
3.	G.=2·63	66·22	16·36	12·79	1·63	0·78	0·83

—*Jour. prakt. Chem.*, lxxvi, 1, in *Kopp's Jahresbericht*, 1859, 778.

Brucite [p. 133, I, II].—Ingelström has discovered this species at three localities near Filipstad in Wermland (Sweden). It occurs in small rounded masses in limestone. Three analyses gave:

		Mg	Fe	H	
G.=2·40	1.	68·80	3·35	28·80 =	100·95
	2.	66·80	3·60	29·50 =	99·90
	3.	68·51	3·83	27·67 =	100·01

The pure mineral contained no carbonic acid.—(*Kongl. Vetenskaps-Akad. Förhandlingar*, 1858, 187.)

Bucholzite.—See under *Sillimanite*.

Chlorotoid [p. 298, V].—T. Sterry Hunt describes the occurrence of *chloritoid* in the crystalline palæozoic schists of Notre Dame Mts. in Canada. At Brome it is found in a fine grained micaceous schist, also at Leeds and other localities in the Notre Dame Mts., it occurs in a similar rock in lamellar masses, rarely more than a quarter inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter, composed of radiating lamellæ, and sometimes making up one-half of the rock. Cleavage of the mineral perfect in one direction, with two less distinct transverse cleavages. Lamellæ often curved, and not easily separable. H. =6. G. =5·13. Color, dark greenish-gray to

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black, brilliant black on the surfaces of perfect cleavage; lustre, on cleavage surface vitreous, on cross fracture waxy; streak, greenish gray. Analysis of a specimen from Leeds:

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
26·30	37·10	25·92	0·93	3·66	6·10=100·01

This variety of chlorotoid has been known among geologists and mineralogists as *phyllite*, and Prof. Hunt shows in his article on this subject (given in this number of this Journal) that Thomson's phyllite from Massachusetts is most probably the same mineral. He further suggests that possibly the *ottrelite* of Haüy may also be a variety of chlorotoid, although this latter suggestion requires further investigation. The abundance of chlorotoid in the schists occurring over wide areas in Canada, and the Green Mountain range, has led Hunt to name these rocks *chlorotoid slate*.

Chrysolite [p. 184, I—IV, VI].—Mr. Edward A. Manice, of the Yale Scientific School, has analyzed the *olivine* found by Prof. O. P. Hubbard in a boulder of coarse basalt at Thetford, Vermont, with the following result:

$\ddot{S}i$	$\dot{F}e$	$\dot{M}g$
40·75	9·36	50·28 = 100·36

The oxygen of the silica, iron and magnesia is 21·73 : 2·08 : 20·11 or $\ddot{S}i : \dot{R}$ as 21·78 : 22·19, equal 1 : 1 or $(\dot{M}g, \dot{F}e)^3\ddot{S}i$.

Grains of green *chrysolite* washed from volcanic-sand found on the sea-shore near Vesuvius, analyzed by Kalle in Rammelsberg's Laboratory (*Pogg. Ann.*, cix, 568) contained $\ddot{S}i$ 40·35, $\dot{M}g$ 46·70, $\dot{F}e$ 12·34=99·39. This gives the formula $\dot{F}e^3\ddot{S}i + 7\dot{M}g^3\ddot{S}i$, corresponding very nearly with the composition of the chrysolite of the Pallas meteorite. Rammelsberg further examined the *white olivine* (Peridote bianco) of Mt. Somma. Occurs in crystals. Sp. gr.=3·243. The pulverized mineral gelatinizes, though with difficulty, with chlorhydric acid. $\ddot{S}i$ 42·41, $\dot{M}g$ 53·30, $\dot{F}e$ 2·33= 98·04. This is identical with the composition of *boltonite* as analyzed by Smith (Suppl. I) and the writer (Suppl. VII).

Clinochlore [p. 293, I, II, V].—Analyses of *clinochlore* from Achmatowsk by Struve (Kokscharow, *Min. Russlands*, iii, 236, in Kenngott's *Uebersicht*, 1859, 54):

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{C}a$	$\dot{H}$
31·64	13·54	5·83	36·20	0·05	12·74
31·52	13·96	6·12	35·68	0·05	12·67

agreeing very closely with the analyses by Craw and v. Kobell of the American and Bavarian mineral.

Copper p. 17, IV, VI].—Hautefeuille has discovered the presence of mercury in a specimen of argentiferous copper from Lake Superior.—(*Compt. Rend.*, xliii, 160, Kenngott, *Uebersicht*, 1859, 108.)

Cronstedite [p. 299].—Damour has reëxamined the *cronstedite* from Przibram, in Bohemia. The mineral is jet-black; opaque; streak dark to olive green; after heating the powdered mineral is perfectly black. H. above 3. G.=3·35. B.B. fuses to a black magnetic mass and with fluxes gives reactions for iron and manganese. Dissolves in acids, and on evaporation yields gelatinous silica. Composition:

$\ddot{S}i$	$\ddot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
21·39	29·08	33·52	1·01	4·02	9·76

[A determination of the sesquioxyd of iron in this mineral by v. Kobell gave 35·35 on which he recalculated one of Steinmann's analyses (see Min.). We add another analysis by Steinmann which has heretofore been overlooked (Schweig. Jour., xxxii, 69), giving it the amount of sesquioxyd of iron in accordance with Damour's results: $\ddot{S}i$ 22·83, $\ddot{F}e$ 29·08, $\dot{F}e$ 31·44, $\dot{M}n$ 3·43, $\dot{M}g$ 3·25, $\dot{H}$ 10·70=100·73. Damour gives the formula $(\dot{F}e, \dot{M}n, \dot{M}g)^6\ddot{S}i + \ddot{F}e^4\ddot{S}i + 6\dot{H}$ or $(\dot{R}^3, \ddot{F}e)\ddot{S}i + 3\dot{H}$.—G.J.B.]

Darwinite.—See *Whitneyite*.

Davyne.—See *Nepheline*.

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DIALLOGITE [p. 446, III, VII].—The variety of this mineral called Himbeerspath, occurring at Oberneisen gave E. Hildebrand on analysis:

C̄	Ṁn	Ċa	Ṁg	Ḟe	
38·94	55·32	2·99	2·07	0·61	= 99·84

DIANITE.—Von Kobell has given this name to a variety of what has heretofore been considered as tantalite, from Tammela in Finland. The specific gravity is 5·5, while that of the tantalite analyzed by Rose, Jacobson, and others varies from 7·38—7·5. The color of the streak blackish-gray; that of the tantalite from Tammela analyzed by Jacobson was dark browniah-red. In other respects *dianite* corresponds perfectly in physical characters with tantalite. Von Kobell, however, finds it to contain a new metallic acid belonging to the same group as tantalic and columbic acids, this he calls *dianic acid*, and the author has also discovered this new acid in euxenite, æschinite and samarskite. For a description of the chemical properties of this acid see this Jour., [2], xxx, 124, and *Bull. der Akad. der Wissenschaften*, March 10, 1860 (Munich).

EPIDOTE [p. 206, II—VII].—R. Hermann has published a continuation of his researches on this species (*Jour. prakt. Chem.*, lxxviii, 295). We quote only the new analyses; the paper is mostly taken up with a discussion of the author's views and objections to the hypotheses advanced by Scheerer.

		S̄i	Ǟl	Ḟe	Fe	Ca	Ṁg	Ign.	
1. Bourg d'Oisans,	G. 3·42.	38·00	20·87	15·06	1·90	21·93	—	2·08	99·84*a*
2. Arendal,	G. 3·37.	37·32	22·85	11·56	1·86	22·03	0·77	2·93	99·31
3. "	G. 3·49.	36·79	21·24	12·96	5·20	21·27	—	2·86	100·32
4. Achmatowsk,	G. 3·41.	40·27	20·08	14·22	2·39	21·61	0·53	0·16	99·26*a*
5. Sillböhle,	G. 3·45.	39·67	18·55	14·31	3·25	20·53	1·62	1·23	Ṅa 0·52 99·68*a*
6. Traversella,	G. 3·47.	40·08	16·91	15·93	1·44	19·11	4·97	1·20	99·64

(*a*) with trace Ṁn.

For a memoir on the crystalline form of *epidote* see v. Zepharovich in *Ber. Wien Akad.*, xxxiv, 480.

FAUJASITE [p. 323].—A. Knop shows from the optical properties of this mineral that it belongs to the *monometric* and not to the dimetric system, in which it has heretofore been classed by many mineralogists.—(*Ann. Chem. Pharm.*, cxi, 375.)

FELDSPAR [p. 228, I—III].—The glassy feldspar from the trachyte of Drachenfels on the Rhine gave Rammelsberg (*Zeitsch. d. deutschen geolog. Gesellschaft*, xi, 437):

S̄i	Ǟl	Ḟe	K̇	Ṅa	Ċa	Ṁg	Ign.	
65·87	18·53	*tr.*	10·32	3·42	0·95	0·39	0·44	=99·92

Rammelsberg considers it an isomorphous mixture of a soda and potash orthoclase. For analyses of the feldspar of the Norwegian zircon-syenite, see *Pogg. Ann.*, cviii, 425.

A. Mitscherlich has found baryta as a constituent of the feldspar from Hohenfels, Rieden, Kempenich, Rockeskill and in the *adularia* from St. Gotthard in quantities varying from 0·45 to 2·33 pr. ct.—(*Jour. prakt. Chem.*, lxxxi, 114.

FERGUSONITE [p. 350, III—VIII].—Nordenskiöld (Jour. prakt. Chem., lxxxi, 200,) gives a new analysis of the so-called *fergusonite* from Ytterby:

C̄b	Ẅ	Ẏ	Ċa	Ū	Ḟe	Ḣ	
46·33	2·85*a*	39·80	3·15	1·12	0·70	6·44	= 100·39

(*a*) with SnO_2.

The crystals are tetragonal, have a dark brown color, translucent on the edges H.=4·5–5. Sp. gr., 4·89. This differs very materially from the composition of the Greenland *fergusonite* as analyzed by Hartwall and Weber, that mineral having been found by these analysts to be anhydrous.

FIBROLITE.—See under *Sillimanite.*

FOURNETITE.—See *Tetrahedrite.*

GARNET [p. 194, I—VIII]—T. S. Hunt has discovered an emerald-green *garnet* at Oxford, Canada, in calcareous-spar with millerite. It is massive, granular, or in transparent dodecahedrons resembling *uwarowite*, but is essentially a lime-alumina garnet, with 6 pr. ct. of chromium (this Journal, xxxi, 295).

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A bright red manganese-alumina-garnet (spessartine) from Miask, analyzed by Lissenko, contained:

	Ṡ	Ä̇l	Ṁn	Ḟe	Ċa	
G.=4·38.	36·30	17·48	30·60	14·32	0·51	=99·21

(Kokscharow, *Min. Russlands*, Kenngott, *Uebersicht*, 1859, 74.)

GERSDORFFITE [p. 58, VII, VIII].—A massive variety of this mineral from Pfingstwiese near Ems afforded Bergemann (*Jour. prakt. Chem.*, lxxix, 412):

S	As	Sb	Ni	Co	Fe	Cu	
21·51	33·25	0·62	22·79	1·64	16·64	4·01	=100·46

Excluding the copper it resembles the ferruginous variety of *gersdorffite* from Schladming in Styria analyzed by Pless.

GIBBSITE [p. 134, 506, IV].—In noticing Rammelsberg's *Mineralchemie* we have already called attention to his treatment of this species. We here repeat, that American mineralogists, after a careful examination of a large number of specimens from Richmond, have been unable to obtain any such phosphate as described by Hermann. The chemical examinations made independently by four different chemists have confirmed the original result as given by Dr. Torrey, namely, that the mineral is a *hydrate of alumina* and even *purer* than the crystalline *hydrargillite* from the Urals.

We do not pretend to determine what Hermann examined, if it was really a phosphate, it most probably did not come from Richmond. We are, however, somewhat at loss to understand the following statement made in Hermann's paper on Gibbsite (*Jour. prakt. Chem.*, xlvii, 1). He says, that to the solution of the mineral in chlorhydric acid, he added a sufficient amount of tartaric acid to prevent precipitation of the alumina, then ammonia in excess, and finally sulphate of magnesia, without producing any precipitate of phosphate of magnesia and ammonia. This is rather a startling fact for a mineral in which he claims to have found from 11·90 to 37·62 pr. ct. of phosphoric acid. The majority of chemists would certainly conclude that this negative evidence was a sufficiently satisfactory demonstration of the absence of any considerable amount of phosphoric acid in Gibbsite. We also have been unable to obtain any reaction for phosphoric acid in *Gibbsite* by the above method, but we have never experienced any difficulty in detecting it by this means in *Wavellite* or phosphate of alumina.—G. J. B.

GIESECKITE.—DesCloizeaux has confirmed the pseudomorphic character of this mineral by an examination of its optical properties.—(2e *Memoire*, 81.)

GMELINITE [p. 321].—Analysis of *gmelinite*, discovered by Gaudry near Pyrgo in the island of Cyprus, by Damour (Bullet. Soc. Géol. (2) xvi, 675, in Jahrb. Min., 1860, 78).

	S̈i	Ä̇l	Ċa	Ṅa	K̇	Ḣ	
G.=2·07	46·37	19·55	5·26	5·51	0·78	22·00	=99·47

GOLD [p. 7, I, II, V–VII].—For Dr. Genth's interesting observations on the occurrence of gold, see this Jour. [2], xxviii, 253. This paper has been translated and republished by Prof. Cotta in his "*Gangstudien*." Freiberg, 1860.

GRAPHITE [p. 92, II–IV].—R. Hermann describes *graphite* from Ajaguss, in the Kirghese-Steppes, covering an extent of country equal to 10 square wersts, (1 werst = 3500 feet) occurring in an impure state in clay slate. This graphitic substance had a slaty structure and contained 40·55 graphite, 56·56 earthy matters, 2·80 water. Specific gravity = 2·60.—*Bull. d. Natur. de Moscou*, 1858, 530, Kenngott, *Uebersicht*, 1859, 105.

HARMOTOME [p. 323, V].—Analyses of *harmotome* from Andreasberg and Strontian, Rammelsberg (*Pogg. Ann.* cx, 624).

	S̈i	Ä̇l	Ḃa	K̇	Ṅa	Ḣ	
1. Andreasberg,	48·49	16·35	20·08	2·07	*tr.*	13·00	= 99·99
2. Strontian,	47·52	16·94	20·25	1·00	1·09	13·45	=100·25

The oxygen ratio of Ṙ, Ä̇l, S̈i, Ḣ, is as 1 : 3 : 10 : 5, taking silica as SiO_2, Rammelsberg gives the formula, (Ḃa, K̇, Ṅa) $\ddot{S}i^3 + \dot{A}l\,\ddot{S}i^3 + 5\dot{H}$. For the relations between this species and *phillipsite* see the original memoir.

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HARRISITE [III, IV].—Dr. Genth informs us that he has now in his collection a specimen of *harrisite* containing a nucleus of unaltered galena; thus substantiating the correctness of his conclusion that *harrisite is copper-glance pseudomorphous of galena.*

HAÜYNE [p. 230].—The blue transparent crystallized haüyne occurring with pyroxene and mica at Monte Somma, examined by Rammelsberg, (*Pogg. Ann.*, cix,) 577, gave in two analyses:

		$\dot{S}$	$\ddot{S}i$	$\dot{A}l$(a)	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	
G.=2·464	1.	11·25	34·04	undet.	10·89	11·47	5·21	
	2.	undet.	34·08	27·64	10·30	12·11	4·71	
Mean,		11·25	34·06	27·64	10·60	11·79	4·96	=100·30
Oxygen,		6·75	17·68	12·91	2·89	3·02	0·84	

(a) with traces of iron.

Subtracting from the oxygen of protoxyds one third of 6·75, or the amount necessary to combine with the $\dot{S}$ present, we have 4·5 remainder, and the relation of $\dot{R}$, $\dot{A}l$, $\ddot{S}i$ will be as 1 : 3 : 4, or, taking silica as SiO_2, the formula $(\dot{R}+\dot{A}l)\ddot{S}i^2$. The oxygen of the protoxyds combined with $\dot{S}$ is to that combined with $\ddot{S}i$ as 2·5 : 4·5 or 1 : 2, consequently the formula of the mineral may be expressed as $\dot{R}\dot{S}+2(\dot{R}\ddot{S}i+\dot{A}l\ddot{S}i)$, or $\dot{R}\dot{S}+\dot{R}^3\ddot{S}i+\dot{A}l^3\ddot{S}i^3=\dot{S}$ 11·10, $\ddot{S}i$ 34·19, $\dot{A}l$ 28·51, $\dot{C}a$ 10·37, $\dot{N}a$ 11·48, $\dot{K}$ 4·35. Rammelsberg calls attention to G. Rose's observation that sodalite, haüyne, and nosean are isomorphous bodies—the silicate $(\dot{R}, \dot{A}l)\ddot{S}i^3$ occurs in all; some haüyne contains chlorine, as well as a certain amount of sodalite. The composition of the three minerals may be expressed as follows:

A. Sodalite $= NaCl+n\,(\dot{R}, \dot{A}l, \ddot{S}i^3)$
B. Haüyne $= \dot{R}\dot{S} +n\,(\dot{R}, \dot{A}l, \ddot{S}i^3)$
C. Nosean $= A \quad +n\,B$

HEULANDITE [p. 330, IV].—A specimen of crystallized heulandite from Tiegerholm in Iceland analyzed by Rammelsberg (*Pogg. Ann.*, cx, 525) lost 1·91 pr. ct when the air-dried mineral was left for two days over sulphuric acid, and 13·5 additional on ignition, in all 15·48 pr. ct. Composition:

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	$\dot{H}$	
	59·63	15·14	6·24	2·35	0·46	15·48	=99·30
Oxygen	30·95	7·07	1·78	0·40	0·12	13·74	

The ratio of $\dot{R} : \dot{A}l : \ddot{S}i : \dot{H}$ is nearly 1 : 3 : 12 : 6, considering the loss of 1·91 as hygroscopic water, the dry mineral contains $\ddot{S}i$ 60·97, $\dot{A}l$ 15·49, $\dot{C}a$ 6·38, $\dot{K}$ 2·40, $\dot{N}a$ 0·47, $\dot{H}$ 13·57=99·28, giving the oxygen ratio 1 : 3 : 12 : 5, the same as given in the Mineralogy. Rammelsberg, however, considers the former ratio to be more correct, as the zeolites easily part with a portion of water and 1·91 pr. ct. is too much to be called hygroscopic moisture. He gives the formula $(\dot{C}a, \dot{K}, \dot{N}a)^2\ddot{S}i^3+\dot{A}l^2\ddot{S}i^9+12\dot{H}$, which is the same general formula as stilbite, and in this view these minerals may be regarded as heteromorphous bodies. [It is deserving of notice that German authors use the name *stilbite* for the species which the English and American authorities call *heulandite*, and *desmine* for the mineral we designate as *stilbite*.—G. J. B.]

HJELMITE.—*Nordenskiöld, Jour. prakt. Chem.*, lxxxi, 202.—This name is proposed by Nordenskiöld for a new tantalate found at Kararfshof in Sweden. Crystalline form, undetermined. Color, jet black; lustre, metallic; fracture granular; H.=5·0; G.=5 82; streak, blackish-gray. B.B. decrepitates, falls to pieces and gives off water. In oxydizing flame becomes brown, but does not fuse; with salt of phosphorus dissolves to a bluish-green glass; with borax gives a colorless glass, which becomes opaque on flaming; with soda and charcoal yields metallic spangles. The minerals occur with *pyrophysalite, garnet, gadolinite*, in a rock composed of quartz, orthoclase, albite (?) and mica. Composition:

$\dot{T}a$	$\dot{S}n$	$\dot{C}u$	$\dot{C}a$	$\dot{Y}$	$\dot{C}e$	$\dot{U}$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$	
62·42	6·56[a]	0·10	4·26	5·19	1·07[b]	4·87	8·06	3·32	0·26	3·26	=99·37

(a) with $\dot{W}$. (b) with $\dot{L}a$ $\dot{D}i$.

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HÖRNESITE.—Haidinger has given this name to a new hydrated arseniate of magnesia from the Banat, first observed and recognized as a new species by Dr. Kenngott, on a specimen in the Imperial Mineral Cabinet at Vienna. It occurs in talc-like, stellated, columnar and foliated snow-white pearly masses, in a gray coarsely granular calcite. Crystalline form, monoclinic. The foliæ are transparent, optically bi-axial; lustre on cleavage surface pearly; foliæ, flexible; H. = 0·5–1·0. G. = 2·474. According to von Hauer it is insoluble in water, but easily soluble in acids. Composition:

$\dot{M}g$	$\ddot{A}s$	$\dot{H}$
24·54	46·33	29·07=99·94

giving exactly the formula $3\dot{M}g\,\dot{H}+\dot{H}^6\ddot{A}s$ or $\dot{M}g^3\ddot{A}s+8\dot{H}$, analogous to the general formula $\dot{R}^3\ddot{A}s+8\dot{H}$ for erythrine, annabergite, köttigite and symplesite.—(Kenngott, *Uebersicht*, 1859, 17.)

HYDROMAGNESITE [456].—P. Meyer describes an impure variety of hydromagnesite as occurring at Kaiserstuhl in Baden.—(*Ann. der Chem. und Phar.*, cxv, 129.)

KAOLIN [p. 249, V].—Analysis by A. Knop in *Jahrbuch für Mineralogie*, 1859 573:

$\ddot{S}i$	$\ddot{A}l$	$\dot{K}$	$\dot{H}$
49·92	35·23	*tr.*	14·85=100·00

KERAMOHALITE [p. 382].—Analysis of the so-called *keramohalite* from Maderan by Schweizer (Kenngott, *Uebersicht*, 1859, 12):

$\ddot{S}$	$\ddot{A}l$	$\dot{M}g$	$\dot{M}n$	$\dot{F}e$	$\dot{K}$	$\dot{C}u$	$\dot{C}a$	Insol.	Cl	$\dot{H}^a$
35·96	10·55	3·74	2·51	1·06	0·58	0·22	0·27	1·12	*tr.*	44·26

(a) With some ammmonia.

Appears from Schweizer's experiments to be a mixture of alum, with ($\dot{M}g$, $\dot{M}n$, $\dot{F}e$) $\ddot{S}$ &c. Kenngott shows that Stromeyer's *mangan-magnesia-alum* may be a similar mixture.

LABRADORITE [p, 237, VII, VIII].—A white feldspar from Radauthal in the Harz examined by Rammelsberg contained:

	$\ddot{S}i$	$\ddot{A}l$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	Ign.
G.=2·817.	51·00	29·51	11·29	0·28	3·14	2·09	2·48=99·79

Is essentially *labradorite*.—(*Zeitschr. der deutschen geolog. Gesellsch.*, xi, 101, in Kopp's *Jahresbericht*, 1859, 785.

LAPIS-LAZULI [p. 229, V, VI].—Bergeron has described a variety of lapis-lazuli from Coquimbo, Chili, which phosphoresced strongly on heating.—(*Bull. de la Soc. Géologique*, [2], xvii, 432.)

LEAD [p. 17, III, IV].—C. v. Reichenbach has found native lead in small globules in a variety of basaltic tufa at Rautenberg in northern Moravia.—(*Verhandl. d. k. k. geolog. Reichsanstalt*, in Kopp's *Jahresbericht*, 1859, 769.)

LEUCITE [p. 231, III, V, VI].—Bergemann (*Jour. prakt. Chem.*, lxxx, 418) describes a pseudomorph of *leucite* from Oberwiesenthal which occurs in perfect icositetrahedrons; H. = 5·5; Sp. gr. = 2·5616. B.B. acts like orthoclase; partially decomposed by prolonged digestion in chlorhydric acid, in one case 5·94 pr. ct. was taken up. Composition of the whole mass after ignition:

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$
60·46	22·11	1·98	1·22	13·53	0·52=99·82

Loss by ignition 1·22 pr. ct. The anhydrous mineral has the oxygen ratio 1 : 3·1 : 9·4 or nearly that of an oligoclase, in which the soda is replaced by potash.

LIBETHENITE [p. 420, VIII].—This species occurs at the "Mercedes" mine near Coquimbo associated with tagilite and limonite. It has a dark olive-green color and a resinous or waxy surface. Composition, according to F. Field (*Chem. Gazette*, June 15th, 1859.): $\dot{C}u$ 66·42, $\ddot{P}$ 29·81, $\dot{H}$ 3·74

LIEBENERITE.—DesCloizeaux has proved this mineral to be a pseudomorph by an examination of its optical properties. (2e *Memoire*, 80.)

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MASCAGNITE.—On page 380 in the Mineralogy the formula for this species should read NH^4O, $SO^3+\dot{H}$ instead of $2\dot{H}$.

MELACONITE [p. 109].—Kenngott (*Uebersicht*, 1859, 97) considers the crystals of this mineral to be pseudomorphs, a view already advocated by Teschmacher and Hayes, who suggested that the crystals might have been altered from the red-oxyd of copper. In opposition to this view, J. D. Whitney (see Min.) has shown that the crystals of cuprite occuring in the same vein with melaconite are uniformally *octohedral*, and in his opinion there is no sufficient reason for considering the crystals pseudomorphs.

MELANHYDRITE.—A new mineral found in a decomposed wacke from Schmelzerthal near Honnef on the Rhine; described by A. Krantz (*Verhandl. d. naturhist. Verein d. Rheinlande u. Westphalens*, xvi, 154). It is amorphous, occurs in irregular nodules, with conchoidal fracture; opaque; color, velvet-black to brownish-black; streak, blackish-brown. Does not fall to pieces when placed in water. In small fragments adheres to the tongue, G. = 1·82. Analysis by Rammelsberg:

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{C}a$	$\dot{H}$	
41·63	18·72	2·36	7·83	2·51	5·23	1·67	20·71	= 100·66

giving the formula $\dot{R}^3\ddot{S}i^2+2\dot{R}\ddot{S}i+12\dot{H}$ a composition near that of *palagonite*. (Kopp's *Jahresbericht*, 1859, 795.)

MELLITE [p. 475, II, VII].—Kokscharow describes two localities of this mineral in Russia, one at Malöwka in Government Tula, the other near Nertchinsk. The author gives new measurements, and an analysis of the specimens from Malöwka by J. v. Iljenkow.—(*Kokscharow Mat. Min. Russ.*, iii, 217, in Kenngott, *Uebersicht*, 1859, 119.)

	C	$\dot{A}l$	$\dot{H}$
G. = 1·597	21·18	14·20	44·16

The amount of carbon corresponds to 42·36 pr. ct. of mellitic acid, so that the results agree very closely with those obtained by Wöhler for specimens from Artern.

MICROCLINE [p. 242, VI, VII].—Scheerer has analyzed the feldspar in which the Norwegian *spreustein* is imbedded, and also the feldspar inclosed in the spreustein crystals, (Pogg., cviii, 430, in Kopp's *Jahresbericht*, 1859, 785). Anal. 1, is the outer, and 2, the enclosed feldspar.

		$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	Ign.	
G. = 2·580	1.	66.03	19.17	0·31	0·20	6·96	6·83	0·21	= 99·71
	2.	65·68	19·53	0·52	0·22	6·93	7·11	0·11	= 100·10

This proves the feldspar matrix and the inclosed nucleus to be identical.

MONROLITE.—See under *Sillimanite*.

MONTICELLITE [p. 184].—An examination of this mineral by Rammelsberg (*Pogg. Ann.*, cix, 569), shows it to be distinct from chrysolite, a fact already indicated by Scacchi. The crystals analyzed had a yellowish-gray color. Sp. gr. 3·119. B.B. rounded only on the edges. The white powder is perfectly soluble in chlorhydric acid, but by heating gelatinizes. Composition;

	$\ddot{S}i$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$	
	37·89	34·92	22·04	5·61	= 100·46
Oxygen,	19·67	9·98	8·82	1·24	

The oxygen ratio of the silica to the bases is 19·67 : 20·04 or 1 : 1 the same as in chrysolite, but the mineral is an isomorphous mixture of nearly equal parts of a silicate of lime, and silicate of magnesia, a portion of the latter being replaced by protoxyd of iron. Formula $\dot{C}a^2\ddot{S}i+(\frac{1}{2}\dot{M}g, \frac{1}{2}\dot{F}e)^2\ddot{S}i = \ddot{S}i$ 38·13, $\dot{C}a$ 34·65, $\dot{M}g$ 21·65, $\dot{F}e$ 5·57 = 100. Monticellite has the crystalline form, but not the cleavage of chrysolite. The composition is the same as that of Breithaupt's *batrachite*, and the latter must henceforth be classified under monticellite.

NACAITE.—See *Pholerite*.

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NATROLITE [p. 327, VI, VIII].—I have analyzed the natrolite recently found at Bergen-Hill, New Jersey, in the greenstone taken from the tunnel constructed by the New York and Erie Rail Road Company. Composition:

	$\ddot{S}i$	$\ddot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
G.= 2·249	47·31	26·77	0·41	15·44	0·35	9·84=100·12

showing it to be a very *pure natrolite* and not *thomsonite* as has been supposed by some mineralogists.—G. J. B.

NEPHELINE [p. 282, II, VIII].—The so-called *davyne* of Monticelli and Covelli placed in the mineralogy under nepheline, has recently been examined by Rammelsberg (*Pogg. Ann.*, cix, 579). The results obtained show davyne to differ from nepheline only in containing carbonate of lime. The crystalline form and cleavage are the same. Analyses:

	$\ddot{S}i$	$\ddot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$	$\ddot{C}$
1.	38·76	28·10	9·32	15·72	1·10	1·96	5·63 = 99·59
2.	36·81	28·66	10·33	15·85	1·21	—	6·01
3.	36·96	28·31	9·39	—	—	—	6·04

If the carbonic acid and an equivalent amount of lime be subtracted in (1) we have $\ddot{S}i$ 45·41, $\ddot{A}l$ 32·92, $\dot{C}a$ 1·97, $\dot{N}a$ 18·41, $\dot{K}$ 1·29. This is *nèpheline*, and *davyne* may be regarded as a compound of carbonate of lime with *nepheline*, analogous to the composition of *cancrinite* as given by G. Rose. Cancrinite differs from davyne in that the amount of lime it contains is not sufficient to saturate the carbonic acid, and a portion of the carbonic acid must be assumed to be combined with soda. If these two minerals contained carbonic acid combined only with lime, and that in an invariable quantity, it could be assumed, as nepheline and carbonate of lime crystallize in the same form, that they might possibly be isomorphous mixtures. But Rammelsberg remarks that the varying amounts of lime and water (in some specs. $\dot{H}$ = 4 pr. ct.), make it more rational to consider both minerals as *nepheline* to a certain extent altered, by the introduction of carbonate of lime—an analogous decomposition being found in the scapolite group.

OTTRELITE.—See *Chlorotoid.*

PARALOGITE.—See *Scapolite.*

PECTOLITE [p. 305, II, III, V—VIII].—Ingleström has found *pectolite* at Langbans Iron-Mine in Wermland, associated with chlorite and calcite. The mineral resembles asbestos. B.B. gives off water and fuses easily to a white enamel. A partial analysis gave—(*Jour. prakt. Chem.*, lxxxi, 396.)

$\ddot{S}i$	$\dot{C}a$	$\dot{N}a$ $\dot{K}^{(a)}$	$\dot{F}e$ $\dot{M}n$	$\dot{H}$
52·24	33·83	8·48	1·75	3·70

(*a*) by the loss.

PHILLIPSITE.—For remarks on the formula of, see Rammelsberg's article in *Pogg. Ann.*, cx, 622.

PHOLERITE [p. 251, VIII].—Mr. Richard Müller of Carlsruhe has communicated to Prof. Dana the following analysis of the so-called *nacrite* (Nakrit) recently found at the *Einigkeit* mine in Freiberg, Saxony. It occurs as a white, scaly crystalline aggregate in seams in gneiss and is associated with galena. Composition:

	$\ddot{S}i$	$\ddot{A}l$	$\dot{H}$
	46·74	39·48	14·06
Oxygen,	24·92	18·45	12·97

The ratio of $\ddot{S}i$, $\ddot{A}l$, $\dot{H}$, is as 4 : 3 : 2 and Müller gives the formula $\ddot{A}l^3\,\ddot{S}i^4+6\dot{H}$ or $\ddot{A}l,\,\ddot{S}i^3+2\dot{H}$. This is exactly the formula and composition found by Dr. Genth for the *pholerite* of Tamaqua, Pa. (this Jour., [2], xxviii, 251, and Suppl. VIII). Knop gives an analysis of an impure *pholerite* from Niederrabenstein in Jahrbuch für Mineralogie, 1859, 545.

PHOSPHOCHALCITE [p. 425, II, VI—VIII].—F. Field describes crystals from a mine near Coquimbo which have a turquoise blue-color and consist of

$\dot{C}u$	$\ddot{P}$	$\dot{C}a$	Ca Cl	$\dot{H}$
20·93	37·69	36·64	2·33	2·32 = 99·91

This he represents by the formula $2(\dot{C}u^6, \ddot{P}\dot{H}^3)+10(\dot{C}a^3, \ddot{P})+$Ca Cl or 2 atoms phosphocalcite, 10 atoms of tribasic phosphate of lime, and 1 atom of chlorid of cal-

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cium. It occurs with a hydrous apatite, and it may be questionable whether the mineral is of uniform composition, there is however no doubt that the copper exists in the mineral as phosphate.—(*Chem. Gazette*, June 15th, 1859.)

PHYLLITE.—See *Chlorotoid.*

PINITOID; A. Knop (*Jahrb. Min.*, 1859, 558).—This new name has been given to a constituent of a rock occurring near Chemnitz, in Saxony. The rock consisted according to Knop, of quartz 58·06, mica 6·19, feldspar 8·44 and pinitoid 25·73=98·42. The *pinitoid* was dissolved out from the other species by sulphuric acid. It is a micro-crystalline mineral of a clayey and compact character. Color leek oil and grayish-green sometimes passing into white and red. G.=2·788, H.=2·5. It is a secondary product, and frequently occurs as pseudomorph after feldspar in decomposed porphyry. Composition:

Si̇	Ä̇l	Ḟe	K̇	Ṅa	Ṁg	Ṁn	Ḣ
47·77	32·65	8·94	5·86	1·50	0·49	*tr*	4·19=101·40

This corresponds so closely to some of the analyses of the Saxon *pinite*, that it is to be regretted the author has embarrassed the science with a new name for a species already overloaded with synonyms.

PISANITE, *Kenngott, Uebersicht*, 1859, 10. This name is given by Kenngott to a cupreous variety of copperas from Turkey, analyzed by Pisani, noticed in the VIII Suppl. under *copperas.*

POLYCRASE [p. 357].—This species has been found by E. Zschau in the syenite of the Plauenische Grund near Dresden, (Letter from Prof. Geinitz).

PROUSTITE [p. 78].—Analysis of *proustite* from Chile by F. Field (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	As	S
64·88	15·12	19·81=99·81

$3AgS, AsS_3$.

PYRARGYRITE [p. 77, IV].—Dark-red silver from Chile gave F. Field on analysis (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	Sb	S
59·01	53·16	17·45 = 99·62

$3AgS, SbS_3$.

PYROXENE [p. 158, I, II, V—VIII].—Crystals of pyroxene from Vesuvian lava of the eruption in 1631, analyzed by Wedding (*Kopp's Jahresbericht*, 1859, 780).

Si̇	Ä̇l	Ḟe	Ḟe	Ċa	Ṁg	Ṁn
48·86	8·63	2·73	4·54	20·62	14·01	*tr.* = 99·39

For observations on crystals of pyroxene from Warwick by vom Rath, see *Pogg. Ann.*, cxi, 263.

RUTILE [p. 120, V, VII].—Observations on the crystalline form of, see Kokscharow in Bull. Imp. Acad., St. Petersburg, i, 229. For Haidinger's remarks on the crystals of rutile from Graves' Mountain, Wien Akad. Abhand. January 5, 1860.

SARCOLITE [p. 200, II, VI).—Rammelsberg (*Pogg. Ann.* cix, 570) has made a complete chemical and crystallographic examination of this mineral, confirming the results given by Scacchi. Occurs in transparent dimetric octahedrons; color, reddish white; sp. gr. =2·932. Gelatinizes with chlorhydric acid. B.B. fuses to a white enamel.

	Si̇	Ä̇l	Ċa	Ṅa	K̇	Ḟl
1.	39·79	22·15	31·59	3·30	1·20	*tr.* = 98·03
2.	40·78	21·07	——	——	——	
3.	40·97	21·30	33·14	——	——	
Mean,	40·54	21·54	32·36	3·30	1·20	*tr.* = 98·91
Oxygen,	21·03	10·34	9·24	0·84	0·20	

The oxygen ratio of $\dot{R} : \ddot{A}l : \dot{S}i$ is as 1 : 1 : 2, the same as in garnet. Rammelsberg writes the formula $3(\dot{C}a, \dot{N}a, \dot{K})^2\dot{S}i + \ddot{A}l^2\dot{S}i^3$. This analysis agrees with the results obtained by Scacchi (Min. p. 200). Sarcolite differs from humboldtilite in containing no magnesia, but the two minerals are nearly related and both have the same crystalline form.

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SCAPOLITE [p. 201, I, II, V).—An examination of *paralogite* by Kokscharow proves it to be dimetric, confirming its identity with scapolite, as previously suggested by Kenngott (*Bull. Imp. Acad. de St. Petersbourg*, i, 229).

SERPENTINE [p. 282, I–VIII].—C. W. Hultmark has analyzed the *chrysotile* and *serpentine* from Sala, Sweden (*Jour. prakt. Chem.*, lxxix, 378).

		$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$	$\dot{O}$
Chrysotile,	1.	41·03	1·43	1·25	42·31	*tr.*	13·72	*tr.*= 99·74
Serpentine,	2.	41·02	1·84	1·81	42·21	*tr.*	12·91	0·48=100·27

SILLIMANITE [p. 265, 513].—An optical examination of this mineral by DesCloizeaux has finally set at rest the question as to its relations to *kyanite*. Its optical properties prove it to be monoclinic, while kyanite is triclinic. With this species DesCloizeaux classes *fibrolite*, *bucholzite*, *xenolite*, *wörthite*, *bamlite* and *monrolite*. These all have the same optical properties, and they also differ from kyanite in density. A new analysis of sillimanite by Damour gave: (*Ann. des Mines* [5], xvi, 219.)

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$
39·06	59·53	1·42	0·28=100·28

from which DesCloizeaux concludes that the composition of sillimanite is $\dot{A}l^4\ddot{S}i^3$, while kyanite is $\dot{A}l^3\ddot{S}i^3$. To establish this point fully, will require an accurate examination, not only of the varieties of sillimanite, but also of fibrolite and other allied minerals.

SILVER [p. 15, III, IV].—A pseudomorph of *silver* after stephanite is described by G. vom Rath in *Pogg. Ann.*, cxi, 266.

SODALITE [p. 229, II, VI, VIII].—Two varieties of *sodalite* from Monte Somma have been analyzed by Rammelsberg (*Pogg. Ann.*, cix, 574). 1. *Colorless sodalite*, crystallizes in regular dodecahedrons and is associated with augite and mica; sp. gr. 2·136. 2. *Green sodalite*, is more rare, crystallizes in dodecahedrons with cubic planes, occurs in limestone with idocrase and nepheline. The analyses, calculating the chlorine as combined with sodium give:

	$\ddot{S}i$	$\dot{A}l$	$\dot{N}a$	Cl	Na
1.	38·12	31·68	18·49	6·69	4·37=99.35
2.	38·76	34·62	21·18	2·55	1·67=98·78

The oxygen of the soda, alumina and silica in (1.) is 4·74 : 14·79 : 19·79; in (2.) 5·43 : 16·17 : 20·12, or very nearly 1 : 3 : 4 in both varieties.

Rammelsberg considers it as $(\dot{N}a+\dot{A}l)\ddot{S}i^3$ combined with varying portions of chlorid of sodium. In (1.) the amount of sodium combined with the chlorine is equal to one-third the soda existing as silicate, while in (2.) it is but one-ninth. The formulas given for the two varieties are:

1. $NaCl+3(\dot{N}a\ddot{S}i+\dot{A}l\ddot{S}i)=2NaCl+3(\dot{N}a^2\ddot{S}i+\dot{A}l^2\ddot{S}i^3)$
2. $NaCl+9(\dot{N}a\ddot{S}i+\dot{A}l\ddot{S}i)=2NaCl+9(\dot{N}a^2\ddot{S}i+\dot{A}l^2\ddot{S}i^3)$

The author argues that this double silicate is isomorphous with NaCl, as these substances combined in various proportions still have the same crystalline form. No. 1 has the same composition as the green sodalite from Greenland, and the blue variety from Brevig, Litchfield, Salem, and the Ilmen Mts.

Decomposed sodalite.—In the same memoir Rammelsberg also gives an analysis of a variety of weathered sodalite from Greenland. It occurs in opaque greenish dodecahedrons with black hornblende (arfvedsonite?). Decomposed by acids.

	$\ddot{S}i$	$\dot{A}l$	$\dot{N}a$	$\dot{C}a$	Cl	$\dot{H}$ (loss).
	43·20	32·54	11·42	3·00	*tr.*	9·84
Oxygen	22·43	15·19	2·92	0·86		8·75

The ratio for $\dot{R}$, $\dot{A}l$, $\ddot{S}i$, $\dot{H}$, is nearly 1 : 4 : 6 : 2, for which the author gives the formula $3\dot{R}\ddot{S}i+2\dot{A}l^2\ddot{S}i^3+6aq$, but it may be questionable whether this substance is homogeneous, and worthy of being considered as a distinct chemical compound.

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STILPNOMELANE [p. 287, III, IV].—L. J. Ingleström (Jour. prakt. Chem., lxxxi, 397), has found *stilpnomelane* at Pen Mine in the Parish of Nordmark in Sweden, occurs in veins sometimes four inches in thickness; radiated, foliated, sometimes in globular masses intermingled with actinolite. Composition:

$\dot{S}i$	$\dot{F}e$	$\dot{A}l$	$\dot{M}g$	$\dot{H}$
45·61	37·70	5·00	3·00	9·14 = 100·45

[The author gives no proof that all the iron exists as protoxyd, thus leaving the composition of the mineral in doubt; we have previously drawn attention to the importance of ascertaining the oxydation of the iron in this mineral, when discussing its relations to the American *chalcodite* (this Jour. [2], xxv, 198).—G. J. B.]

TAGILITE [p. 426].—F. Field has analyzed *tagilite* from the "Mercedes" mine near Coquimbo, Chili. It is a beautiful fibrous variety, and occurs in considerable quantity associated with limonite. (Chem. Gazette, June 15th, 1859.)

$\dot{C}u$	$\dot{P}$	$\dot{H}$
61·70	27·42	10·25 = 99·37

This gives the formula $\dot{C}u^4\,\dot{P} + 3\dot{H}$, the same as obtained by Hermann for the original specimens from Nischne Tagilsk.

TALC [p. 275, V].—A peculiar indurated variety of this species occurs in veins in gneiss at Bristol, Connecticut. It has a dark leek green color, and a greasy lustre and feel. H. = 2. G. = 2·82. Analysis by Dr. H. H. Lummis in the Laboratory of the Yale Scientific School:

$\dot{S}i$	$\dot{F}e$	$\dot{M}g$	$\dot{H}$
64·00	4·75	27·47	4·30

TETRADYMITE [p. 21, 512, I, VII].—Analysis of tetradymite from Cumberland England, by Rammelsberg (Min. Chemie, p. 4):

Bi	Te	S
84·33	6·73	6·43 = 97·49

equal to $Bi^4 + Te + S^4$.

The telluret of bismuth from Field's Gold Mine near Dahlonega analyzed by Dr. C. T. Jackson, (this Jour. [2], xxvii, 39), and pronounced by him to be identical in composition with the Brazilian *bornite*, has been reëxamined by Dr. F. A. Genth with the following result: (*Mining Magazine*, (2), i, 358.)

		Bi	Te	Cu	Fe	Au, quartz, &c.	Se	
G. = 7·941	1.	50·83(a)	48·22	0·06	0·17	0·72	*tr.*	= 100·00
	2.	50 97	47·25	0·06	0·25	0.80	*tr.*	= 99·33

(a) by the difference.

This agrees with the composition obtained by Dr. Genth for the *tetradymite* from Fluvanna Co., Virginia, and differs entirely from *bornite*, and the results of Dr. Jackson. This difference is explained by the fact that the methods of analysis employed by Dr. Jackson were unreliable, and consequently gave erroneous results; attention has been called to this point in an editorial notice in Erdmann's Journal für praktische Chemie, lxxix, 507, also in a similar notice in the Réperetoire de Chemie Pure, ii, 288, as well as by Dr. Genth (loc. cit.). Dr. Jackson has replied to Dr. Genth's criticisms (*Mining Magazine*, [2], i, 466) but inasmuch as no new facts or analyses are given, we must consider the Dahlonega *tetradymite* as essentially the same as that from Fluvanna Co., Virginia, and *not identical* with the Brazilian *bornite*.—G. J. B. [Since the above was written Dr. Genth has replied to Dr. Jackson, (*Mining Mag.*, (2), ii, 84, January,) showing the inaccuracies of the methods used by the latter.]

TETRAHEDRITE [p. 82, I, II, V].—*Ch. Mène* has described a new variety of tetrahedrite from Ardillats (Dept. de Rhône) France, which he calls *fournetite*. It occurs with galena in a quartzose porphyry. No physical characters, except density, are given. Its composition in three analyses was:

		Cu	Pb	S	Fe	As	Sb	Quartz
1.	G. = 4·319	26·50	9·90	19·00	2·50	6·60	18·20	16·70
2.	G. = 4·305	23·00	8·70	16·70	2·10	5·80	16 00	27·40
3.	G. = 4·320	26·80	10·50	19·20	2·50	6·70	18·70	15·20

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rejecting the quartz gangue, the mean of the analyses gives Cu 32·00, Pb 12·00, S 23·00, Fe 3·00, As 8·00, Sb 22·0.—(*Comptes Rendus*, li, 463).

TRIPLITE [p. 408].—Bergemann describes a new locality for this mineral at Peilau in Silesia (*Jour. prakt. Chem.*, lxxix, 415). In thin splinters translucent. Color dark-brown almost black; streak, light liver-brown. H.=4. Sp. gr. 3·617. The surface of the mineral is frequently coated with oxyd of manganese. The pure mineral dissolves in chlorhydric acid without evolution of chlorine. Composition:

P	Fe	Mn	Fe	Ca	Mg	Na	Si	Ign.
32·76	31·72	30·83	1·55	1·19	0·32	0·41	0·23	1·28 = 100·29

giving the formula $\dot{Mn}^4\dot{P}+\dot{Fe}^4\dot{P}$.

URANOPHANE.—*Websky* (*Zeitschc. d. deutsch. geol. Gesellschaft*, xi, 384, Kenngott, *Uebersicht*, 1859, 193), has given a more complete notice of this mineral before described by him (loc. cit., v, 427). It occurs in the copper mines at Kupferberg in Silesia. The mineral appears to be compact and amorphous, but the microscope reveals small acicular crystals which in druses have the form of flat hexagonal prisms. Color of crystals honey-yellow, of the compact variety siskin-green. Hardness somewhat less than 3. G.=2·78, specimen not perfectly pure. Lustre, vitreous to pearly. B.B. in glass tube gives reactions for water (alkaline), tellurium, selenium; in forceps, fuses with difficulty to a black glass, and gives a faint green color to the flame; on charcoal, becomes black, gives a reaction for selenium, antimony and bismuth; with fluxes, gives reactions for silica and uranium. Decomposed by both sulphuric and chlorhydric acids. Two analyses by Grundmann, (1) honey-yellow to siskin-green variety, (2) faint grayish-green variety containing pitchblende as impurity:

	Ḣ	Si	Ȧl	Ü	Ca	Mg	K	P	Bi	Sb	Te	Fe	Pb	Cu[b]	Ag	S	
1.	14·11	15·81	5·65	49·84	4·69	1·35	1·71	0·12	1·73	1·46	0·43	0·57	0·29	0·21	0·11	1·66	– 99·74
2.	12·19	11·19	2·80	54·23[a]	3·58	1·19	0·80	0·05	1·77	1·86	0·22	0·89	0·38	5·24	?	3·96	–100·34

(*a*) with some $\dot{U}\ddot{U}$. (*b*) with some Ċu.

after subtracting from (1) 0·81 chalcolite, 0·13 argentite, 0·23 covelline, 0·33 galena, 1·21 iron-pyrites, 1·19 tetradymite, 1·29 bismuth-glance, 0·02 sulphur, there remains, according to Websky, for the composition of *uranophane:*

Ḣ	Si	Ȧl	Ü	Ca	Mg	K
13·99	15·81	5·61	49·33	4·69	1·35	1·71

for which he gives the formula $3(\dot{K}^2\ddot{S}i)+5(\dot{H}^2\ddot{S}i)+36\dot{H}$.

[The mineral is undoubtedly a secondary product, and one may reasonably question its constancy of composition, and its right to be considered a distinct species.—G. J. B.]

VERMICULITE? [p. 292].—In the year 1851 Mr. W. W. Jefferis found near the clinochlore locality at Westchester, Pennsylvania, a peculiar bronzy yellow micaceous mineral, which on examination proved to be optically-biaxial with a low angle, resembling phlogopite, and it has for some years been circulated among mineralogists as a variety of phlogopite.

An examination of this substance made by Prof. J. Lawrence Smith and myself in 1853, showed its composition to be near that of chlorite, and it was considered by us to be a weathered chlorite, although our results were never published. My attention has since been called to this mineral by its peculiar pyrognostic properties. When a fragment of it is heated in the flame of a spirit lamp even without the aid of the blowpipe, it exfoliates in a most remarkable manner swelling up to fifty or more times its original size, thus very much resembling *thermophyllite* and *vermiculite* and altogether differing from *chlorite* or *mica*.

According to a statement communicated to me by Mr. Jefferis, it occurs in a vein in the serpentine rocks fifty yards south of the clinochlore locality; the vein is about two feet wide, and is composed of plates and crystals thrown together in the most irregular manner. The crystals are so soft and friable when first taken out, that it is difficult to handle them, they will scarcely bear their own weight. It is also found in crystals in the soil near the locality. The crystals are six-sided prisms, with a mica like structure and a perfect basal cleavage, they vary form one to three inches in diameter and are sometimes an inch or more in thickness. Mr. Jefferis has

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one large crystal measuring six by four inches. The mineral is optically biaxial; laminæ less flexible than chlorite, almost brittle; color, brownish-yellow, light-yellow by transmitted light. Specific gravity of the air-dried mineral about 2·30. Hardness, between gypsum and common salt. B.B. in forceps exfoliates and becomes pearly white and opaque, and on prolonged heating fuses to a dark gray mass. In closed tube exfoliates, frequently bursting the heated tube, and gives off water which reacts alkaline. With the fluxes gives reactions for silica and iron. Decomposed by chlorhydric acid. The air-dried mineral lost 4·19 pr. ct. in weight by drying in a sulphuric acid desiccator, and 3·74 pr. ct. additional when dried at 100° C.: heated in an air-bath to 220° C. it lost 4·17 pr. ct., but between 220° and 300° C. the loss was scarcely appreciable, and maintained at the latter temperature for half an hour it suffered no farther diminution in weight; at a full red-heat over a blast-lamp it lost 5·85 pr. ct., making in all 17·95 pr. ct. Assuming the amount lost by drying over sulphuric acid to have been hygroscopic moisture, we have 13·76 pr. ct. of water contained in the mineral. It is difficult to determine what amount of water should be included as essential, but it is perhaps safest to take the mineral as dried over sulphuric acid. For analysis the mineral was decomposed by fusion with carbonate of soda—the state of oxydation of the iron was determined by dissolving a separate portion in chlorhydric acid in an atmosphere of carbonic acid, and subsequent titration with permanganate of potash—the alkalies were estimated by Smith's method. Composition:

$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{H}$
37·10	17·57	10·54	1·26	0·56	19·65	0·43	*tr.*	13·76 = 100·87

Other analyses made in 1853 by Prof. Smith and myself gave similar results. The iron in the mineral has undoubtedly been partially oxydized by weathering, many of the crystals are impure from infiltration of foreign matter between the laminæ and they are quite friable from exposure. It belongs to the chlorite section of magnesian hydrous silicates and in view of its pyrognostic properties we refer it with a query to vermiculite, which its chemical composition approximates. The great difficulty of obtaining pure vermiculite in sufficient quantity for analysis has thus far prevented me from reëxamining it, in fact I have delayed publishing my results on the Weschester mineral for more than two years, hoping thereby to be able to determine more fully its relations to this species. The oxygen ratio for the $\dot{S}i$, $\dot{R}$, $\dot{R}$, H as calculated from the analysis is as 19·89 : 11·36 : 8·36 : 11·23 or 7 : 4 : 3 : 4 equal to $3\dot{R}^3\dot{S}i + 4\dot{R}\dot{S}i + 12\dot{H}$ or the more general expression $(\dot{R}^3\dot{R})\,\dot{S}i + Aq$. The mineral is however so much altered by exposure, and so liable to impurities from infiltration of foreign matter, that it is very unsafe to draw any conclusion from the analyses, further than to refer it in a general way to the chlorite group near chlorite and vermiculite. The chief object in mentioning it here, is to call attention to its remarkable pyrognostic properties. The exfoliation in heating is not due to the escape of hygroscopic moisture, as it does not take place to any considerable degree until the mineral is exposed to a temperature above 300° C.—G. J. B.

WATER [p. 110, VIII].—L. Dufour has found the density of ice 0° C., to be 0·9175. —(*Comptes Rendus*, l, 1039.)

WHITNEYITE [VII].—D. Forbes has described (*L. E. & D. Phil. Mag.*, (4), xx, 423,) under the name *darwinite*, an arsenid of copper which is identical in physical and chemical properties with Genth's *whitneyite*. It is stated to occur in veins near Potrero Grande near Copiapo, Chile. It is massive, without cleavage, rather brittle, but may be distinctly impressed by the hammer; fracture uneven; lustre metallic; color of freshly-fractured surface dark silver-grey, on exposure dirty bronze-yellow; streak metalic, silver-grey; opaque. H. = 3.5. G. = 8·64. B.B. gives reactions for copper and arsenic with trace of silver. Composition:

	1.	2.	3.	4.
Cu	88·35	88·07	88·11	88·02
Ag	0·38	0·24	0·08	0·42
As	11·27	11·69	11·81	1156

[These results leave no doubt as to the identity of the mineral with *whitneyite* (see Sup. VIII.) for which Genth obtained Cu 88·07, As 11·81, Ag and insol. 0·33 = 100·21.—G. J. B.]

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WÖHLERITE.—For a memior on the crystalline form and optical properties of, see DesCloizeaux, (*Ann. des Mines* [5], xvi, 229).

WOLFRAM [p. 351, I—III, IV, VIII].—An interesting variety of this species is described by Dr. F. A. Genth (*Mining Magazine*, [2], i, 359). It occurs associated with quartz and mica, about 1½ miles from St. Francis River, St. Francis Co., Missouri; it is said to have been found in considerable quantities. Crystalline and cleavable parallel to the brachydiagonal; color, brownish-black; lustre, sub-metallic; streak, cinnamon-brown; Sp. gr. 6·67. Analyses by G. J. Pöpplein; (1) Decomposed by fusion with carbonate of soda, (2) by chlorhydric acid:

	$\dddot{W}$	Ḟe	Ṁn	Ċa	
1.	75·29	5·69	19·02	1·13	= 101·13
2.	75·52	undet.	19·78	undet.	———

The oxygen ratio of $\dddot{W}$, Ḟe, Ṁn, Ċa, is 15·56 : 1·26 : 4·28 : 0·32, giving a new type of this mineral with the formula $\dot{F}e\,\dddot{W} + 4\dot{M}n\,\dddot{W}$.

XENOLITE.—See under *Sillimanite*.

YTTROTANTALITE [p. 359, IV].—In a memoir (*Jour. prakt. Chem.*, lxxxi, 193) on the chemical and crystallographic characters of the tantalates and columbates of yttria, Nordenskiöld gives a new analysis of *yttrotantalite* and points out the isomorphism of this mineral with polymignite and polycrase. The new analysis of the black variety of yttrotantalite gave:

Ta	Ẅ	Ẏt	Ċa	Ḟe	Ū	Ċu	Ḣ	
56·56	3·87	19·56	4·27	8·90	0·82	*tr.*	6·68	= 100·66

ZINC [VII].—According to G. Ulrich, native *zinc* has been found in basalt near Victoria in Australia. The specimen found weighed 4½ ounces, and was incrusted with smithsonite and aragonite, and a trace of cobalt bloom. Another locality is described by L. Becker as occurring in the gold washings of the Mitta river.—(*Kenngott, Uebersicht*, 1859, 108.)

ZINCITE [p. 110, II, III].—W. P. Blake has described and analyzed a very pure variety of this mineral from Franklin. It has a much brighter and clearer color than the ordinary red-oxyd, more nearly resembling crocoisite or realgar. It is transparent, orange yellow, has a distinct cleavage parallel to the vertical axis of a hexagonal prism, and also a basal cleavage, the latter being free from the black layers which separate the laminæ of the ordinary oxyd. In the specimen described there were several slender hexagonal prisms partially imbedded in a white enamel-like crust, the result of the weathering of the mass. H.=4—4·5. G.=5·684 (at 60°F.) Composition: (*Mining Magazine*, (2), ii, 94.)

Żn	Ṁn	Ign.	
99·47	0·68	·23	= 100·38

ZOISITE [p. 211, IV].—DesCloizeaux has shown from the optical properties of this mineral that it is distinct from epidote, the former belonging to the monoclinic, while the latter has the triclinic form. (*Ann. des Mines*, [5], xvi, 219].

ZWIESELITE [p. 399].—The probable identity of this mineral with triplite is pointed out by Kenngott (*Uebersicht*, 1859, 30). The author shows that the identity of crystalline form and other physical properties is further supported by the similarity of chemical composition, and that *zwieselite* is but a variety of *triplite*.

ERRATA.

Pages 358, 359, 365, 366. For *chlorotoid* read *chloritoid*.

Page 360. The analysis of *diallogite* by Hildenbrand is from the Annalen der Chemie und Pharmacie, cxiv, 348.

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ART. XXXIV.—*On the conversion of certain Conglomerates into Talcose and Micaceous Schists and Gneiss, by the Elongation, Flattening and Metamorphosis of the Pebbles and the Cement;* by Prof. EDWARD HITCHCOCK.

IT will be seen by the statements below that the subject of this paper arrested my attention nearly thirty years since. But it was only within two or three years that I began to realize its importance and resume its investigation in connection with my youngest son, Charles H. Hitchcock. Nor was it till within a few weeks that the locality, which more than any other shows the completion of the metamorphic process for which we contend, was discovered. If we are not mistaken, these facts have an important bearing upon that most difficult subject of geology—*Metamorphism*,—for they show most conclusively the plastic condition of this conglomerate and the associated schists and gneiss, subsequent to their original consolidation. Other strong arguments do, indeed, lead to the same conclusion: such as the change exhibited by the Azoic rocks from a mechanical to a crystalline condition, the complicated foldings and contortions of these rocks, the remarkable curvatures of the veins of granitic rocks; and the existence of superinduced structures, such as no mere mechanical forces could have produced. But I pass by all these proofs now, and present only that from the changes in certain conglomerates.

So far as my knowledge of geological literature extends, the facts, and some of the conclusions presented below, are mainly new; and this is the chief reason why I offer them to this Journal. Professor Sedgwick has, indeed, described joints that "have actually cut through the pebbles of quartzite and other hard masses which enter into the composition of the conglomerates." (*British Palæozoic Rocks*, p. xxxvi, *Introduction.*) But he does not describe the pebbles as elongated, and he calls the joints "*mechanical*," which epithet I am confident he would not apply to the joint in the Rhode Island or Vermont conglomerates. The same thing is described by Jukes, in his Manual of Geology, more fully. He also notices as an effect of cleavage, the "distortion of fossils and other small bodies imbedded in the rocks, lengthening and pulling them in the direction of the cleavage and contracting them in the opposite direction." These facts, first noticed by Prof. John Phillips, have been used by Messrs. Sharpe, Sorby, and others, to sustain the hypothesis of the production of cleavage by "the action of great forces of compression, squeezing the particles of rock in one direction and lengthening them in the opposite." The facts which are presented in this paper harmonize with these views and lead to generalizations still higher, especially to the position so ably defended by Scrope, Beaumont,

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Scheerer and Hunt, of the plastic condition of all the deep seated rocks since their original consolidation, and showing us how rocks mechanically formed are sometimes converted into schists, with entire changes of mineral character. Admitting these conclusions, the whole subject of metamorphism becomes comparatively easy and full of interest. This affords no small relief to one, who, like myself, has been for years perplexed and confounded in studying the highly metamorphic rocks of the Green mountains.

Doubtless many geologists will demur at my conclusions, as I should have done without visiting the localities. I can ask them only to suspend their judgment till they have seen the rocks which I describe, especially those at Newport and at Plymouth. If they shall then propose any more rational theory, I hope I shall be willing and thankful to receive it.

With these preliminary remarks I proceed to the details. We give them as proving and illustrating the following statement, and essentially in the language we shall use in our Report on the Geology of Vermont.

We have found striking examples where the pebbles of conglomerates have been elongated and flattened so as at length to be converted into the silicious laminæ of the schists and gneiss and the cement into mica, talc, and feldspar.

In a Report on the Geology of Massachusetts made by me in the year 1833 a singular conglomerate was described near Newport R. I.:—"composed of elongated rounded nodules of quartz rock passing into mica slate, with a cement of Talcose slate, the nodules varying from the size of a pigeon's egg, to four and even six feet in their longest diameter, and so arranged that their longest diameters are uniformally parallel to one another, lying in a north and south direction. The conglomerate is divided by fissures running east and west vertical to the horizon, and parallel to one another from ten to twenty feet apart. These fissures divide the thick masses of comglomerate so perfectly that they seem as if cut through by the sword of some Titan. The nodules through which the fissure passes, are divided very neatly and the parts present even surfaces, so as to give the rock a quite peculiar aspect."

These facts were repeated in the subsequent Reports upon Massachusetts in 1835 and 1841. But it was not until we found an analagous conglomerate along nearly the whole western side of the Green mountains that the special bearing of the facts above mentioned upon metamorphism occurred to us. Myself and son then (1859) visited Newport to get a clearer view of the facts in the hope that they would help us better to unravel the intricacies of the Vermont conglomerates. That same year I read before the Amer. Assoc. for Adv. of Sci., a paper on the subject, as it was developed at Newport and at E. Wallingford, where an interesting locality had been discovered by Mr. Hager, another of my assistants in the geological survey of Vermont.

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In 1860 my son brought the subject again before the Association for Adv. of Sci. But it was not until after that time that the last link in the argument was supplied by a visit to a locality in Plymouth, Vt., which was also discovered by A. D. Hager. We will now try to state the facts and conclusions as they have been gradually worked out by us. If any should wish to verify our statements and see the force of our reasoning, we advise them to visit the different localities in the order in which we describe them. For the processes began at Newport, seem to be carried to the conclusion in Vermont.

Perhaps the best exposure of the Rhode Island conglomerate is at the well known 'Purgatory,' two and a half miles east of Newport, and within the limits of Middletown. According to the paper of C. H. Hitchcock read before the Am. Association in Aug., 1860, the belt of conglomerate commences a little south of Purgatory, is a mile wide with interstratified belts of slates, and extends N. 30° E. probably as far as Sandy Point, in Portsmouth some 5½ miles. It shows several folds, is underlaid by a gritty schist or sandstone, and itself underlies the coal measures.

"It is a coarse conglomerate, composed of elongated and flattened pebbles, from the smallest size, to bowlders nearly 12 feet long, cemented by a meagre amount of talcose schist, or sandstone," with numerous small disseminated crystals of magnetite. The pebbles are mostly a fine-grained, or compact quartz rock, which when partly decomposed appears like sandstone; not unfrequently the pebbles seem to pass into an imperfect mica schist, and show lamination. A few of them are gneiss, and probably granite, and occasionally hornblende rock. In their shortest diameter they rarely exceed a foot, while in length, one, two, and three feet are very common, and a few may be seen from 4 to 6, and one, at least, is as long as 12 feet. The following facts as to the pebbles, are of the most interest:

1. They are often very much elongated in the direction of the strike; 2. They are flattened, but not so strikingly as they are elongated; 3. They are indented often deeply by one being pressed into another; 4. They are sometimes a good deal bent, occasionally in two directions; 5. They are cut across by parallel joints or fissures, varying in distance from each other from one or two inches to many feet. The most distinct of these joints, which are a rod or two apart; are perpendicular to the horizon, and nearly at right angles to the strike, and make a clean cut from top to bottom of hills 30 or 40 feet high. Abrading agencies have often removed the rock on one side of these joints, or between two of them, so as to leave walls of pebbles smoothly cut in two; the whole appearing like a pile of wood neatly sawed. Acres of such walls may be seen in the vicinity of 'Purgatory.' Often the surface of the pebbles thus cut through is not only perfectly even, but smooth and seemingly polished. Yet the two parts

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of the pebbles thus cut off, perfectly correspond, and one part has never been made to slip over the other. In some minor joints single pebbles are not entirely cut off, but are sometimes drawn out of their beds at one end where the rock is separated, and remain projecting above the cleared surface. These joints do not always extend through the whole rock.

We should be glad to introduce here many sketches of specimens illustrating these statements. But one or two must suffice:—

Fig. 1 will give some idea of an elongated pebble from Newport, which is 10 inches long and 3 inches across its broadest part.

1.

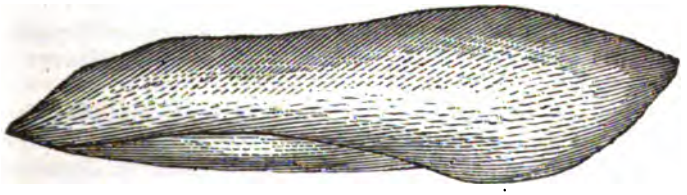
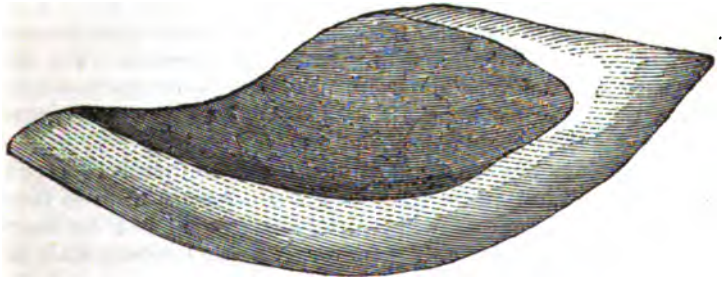


Fig. 2 shows a pebble 8 inches long with a deep indentation.

2.



Perhaps I ought to add that sometimes the elongated pebbles partially or wholly lose their rounded form at the ends, and begin to assume a foliated or schistose aspect, and to be somewhat blended with the talcose or micaceous cement. This though not general, is frequently the case.

From these facts we could hardly avoid drawing the following conclusions:

1. This rock was once a conglomerate of the usual character, except in the great abundance of the pebbles, and it has subsequently experienced great metamorphoses making the cement crystalline and schistose, and elongating and flattening the pebbles. 2. The pebbles must have been in a state more or less plastic, when they are elongated, flattened and bent. If their shape has been thus altered, their plasticity must of course be

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admitted; for the attempt to change their present form would result only in fracture and comminution. The degree of plasticity, however must have varied considerably; for some of them are scarcely flattened or elongated at all—and as has been stated, some are not cut off by the joints.

The neat and clean manner in which the pebbles have been generally severed by the joints, implies plasticity.

For though occasionally we meet with one that has a somewhat uneven surface, as if mechanically broken, such cases are rare. Whatever may be our theory of the agency that has formed the joints, the conviction is forced upon every observer that the materials must have been in a soft state after their original consolidation. There is no evidence that the opposite walls have slid upon one another at all, as the opposite parts of the pebbles coincide. It seems as if a huge saw or cleaver had done the work.

These proofs of plasticity apply essentially, though less forcibly to the micaceous and talcose cement which has also been cut across by these joints. Though generally small in quantity it sometimes forms layers of considerable thickness interstratified with the pebbles.

Some have imagined that the elongated, flattened, bent, and indented pebbles of this conglomerate may have been worn into their present shape and brought into a parallel arrangement by the mechanical attrition of waves and currents. We feel sure that an extensive and careful examination of the localities, and of beaches where shingle is now being formed, will convince any one that they cannot have had such an origin.

1. We do not believe that any beach can be found with pebbles that have anything more than a slight resemblance to those at Newport. Those somewhat elongated may indeed be found where they are derived from slate rocks. But nowhere does the attrition of pebbles against one another produce deep indentations, and leave the one neatly fitting into the other, nay, one bent partially around the other, as is the case at Newport. If these phenomena were produced by original attrition how strange that they should have such an extraordinary development on Rhode Island, while it is not marked enough in any other conglomerate in our country save in Vermont, to have arrested the attention of geologists.

2. The remarkable joints in this conglomerate prove that the pebbles have been in a plastic state, and since the strata have been much folded, and consequently subjected to strong lateral pressure, how could the pebbles have escaped compression and modification of form? A mass of the conglomerate when broken open along the line of strike, a good deal resembles a plug of tobacco, which has been rolled into lumps and then subjected to strong pressure, so that the lumps are distorted and made to conform to all the irregularities around them.

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3. The force by which the pebbles were flattened and indented must have operated laterally, as would result from the plication of the strata; folds in which are frequent. If there was a great superincumbent pressure and less in the direction of the strike, the same lateral force might have elongated the pebbles. But perhaps there may have been also a horizontal curvature in the strata, to aid in the work, as we shall explain when we come to describe the Vermont localities. It may not, however, be easy to show how this compressing force has operated where rocks have been so folded and disturbed as around Newport, for the conglomerate is in juxtaposition with granite, which has exerted a powerful metamorphic influence on other strata there; but if we can show the results of the agency, our main object will be accomplished.

4. The phenomena of the joints in this rock, conduct us most naturally to some polar force as the chief agent in their production. Mere shrinkage could not have separated the pebbles as smoothly; much less could a strain from beneath have thus fractured them; for sometimes the joints are not more than two or three inches apart, and if we suppose one of them to have been the result of fracture, yet how is the other to be obtained in that manner? A simple inspection of the rock in place will satisfy any one that no mechanical agency is alone sufficient to explain these phenomena. We have been driven to the supposition of some polarizing force acting upon soft materials. If, as Sir John Herschel supposes, cleavage may have resulted from a sort of crystallization in plastic materials, why may not joints come into the same category? Why should the conclusions drawn from the experiments of Mr. Fox upon the lamination of plastic clay, by electric currents, be limited to cleavage?

5. The Newport conglomerate is probably only a special variety of the extensive deposit of highly silicious pudding-stone found so abundantly between Boston and Rhode Island. Both have the same geological position, we believe, and were the Roxbury conglomerate to be brought into a plastic state, and the pebbles elongated and flattened by pressure, we think the result would resemble the Newport conglomerate.

Thus far we are legitimately conducted, we think, by the Rhode Island rock. We are carried farther by the Vermont conglomerates, which we now proceed to describe. We select two localities, although doubtless many others might be found equally instructive. The rock occurs on both faces of the Green Mountains, and we can hardly doubt that it once formed a fold over the mountains, which denudation has swept away.

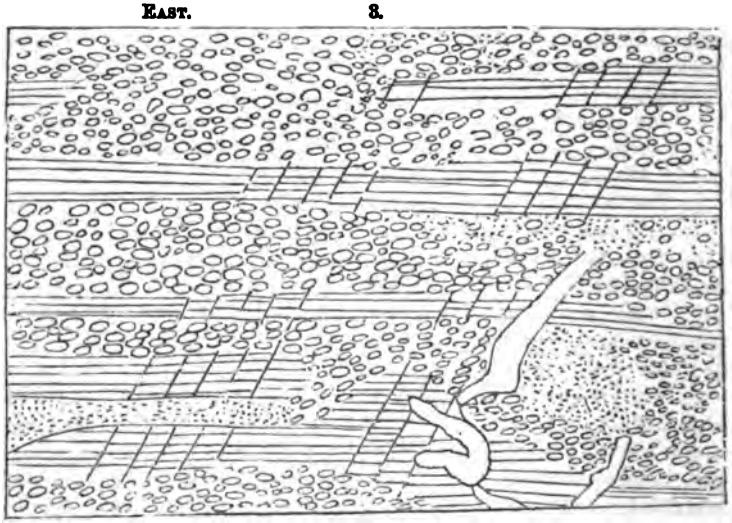
We have found this rock in connection with quartz rock, mica and talcose shists, and gneiss; sometimes merely in juxtaposition, as in the case of the quartz rocks, but sometimes interstratified. The conglomerates at the different localities may not

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be identical as to geological age; yet we incline rather to the opinion, that quartz rocks, micaceous and talcose schist and gneiss, may be varieties of the same original rock, which metamorphism has sometimes converted into one and sometimes into others of the series. Quartz rock may be the residuum of certain silicates; the schists and gneiss are these silicates modified; any of these rocks, we think, might be formed out of the conglomerate under consideration, as we shall now endeavor to show. If so, we might perhaps find it in connection with them all, without implying a difference of age.

In the N.E. part of Wallingford, Vt., on the western slope of the Green Mts. on the hill north of David Hager's, is an interesting exhibition of the conglomerate. Numerous bowlders are scattered over the fields, which are instructive, but the embossed ledge half a mile north of Hager's is most so. It has been rounded and smoothed by the drift agency so as to show the pebbles and their alteration with the schists, very distinctly, as the following sketch of a portion of the ledge, taken by A. D. Hager, my assistant in the geological survey of Vermont, will evince. It will be seen that the schist often containing small pebbles or coarse grains of sand, is interstratified somewhat irregularly with the pebbles; just as we often see in the alluvial deposits, and in the sandstones that have not been metamorphosed. The drift striæ are quite distinct upon it, running southeasterly, as shown on the sketch, fig. 3.

EAST. 3.



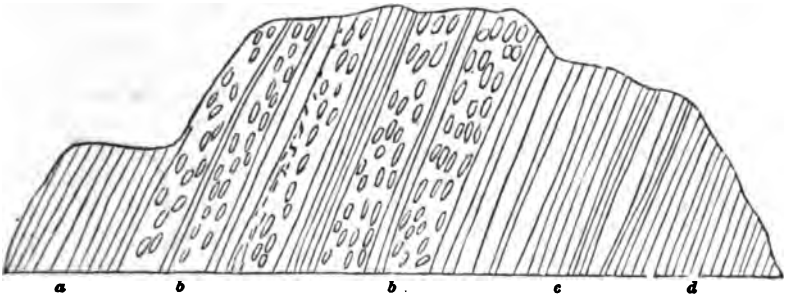
WEST.

The strike of these strata is about N.E. and S.W. and the dip 70° W., but it sometimes rises to 90° near by. To show its position in respect to a micaceous quartz rock, approaching micaceous schist, on the upper side, and to the Green mountain gneiss below it, we give the adjoining sketch, Fig. 4. These rocks constitute a single massive ledge,

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with very few distinct strata-seams, and they seem as if only varieties of the same rock.

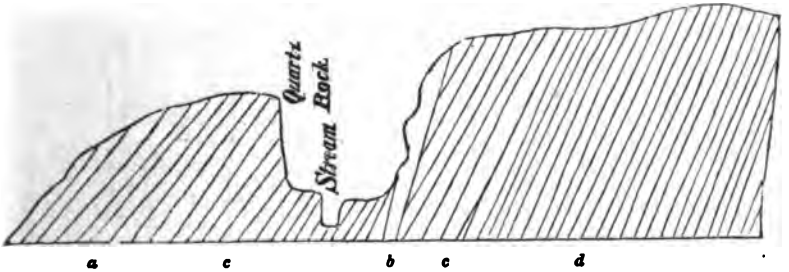
4.



a, micaceous quartz rock; *b*, *b*, conglomerate alternating with talc schist; *c*, talc schist; *d*, gneiss.

To show that the gneiss sometimes lies above the quartz and the schist, we give the following section, Fig. 5, only a few rods long, taken at an easily accessible locality, on the east side of the mountain; where, as we shall shortly see, the same rocks occur in juxtaposition. In the road from Ludlow to Mt. Holly, and near the line between the two towns, a small stream has cut a gorge, 40 or 50 feet deep, through a ledge of quartz rock. On the west side a trap dyke occupies a considerable part of the face of the rock, though more or less worn away. Talcose schist succeeds the quartz rock on the west side, dipping beneath it at a high angle. But on the east side, and lying upon the quartz at a less dip, is distinct gneiss, with more of feldspar than is usual in the Green mountain gneiss. The section below will give an idea of these facts, fig. 5.

5.



a, gneiss; *b*, trap dyke; *c*, *c*, quartz rock; *d*, talcose schists.

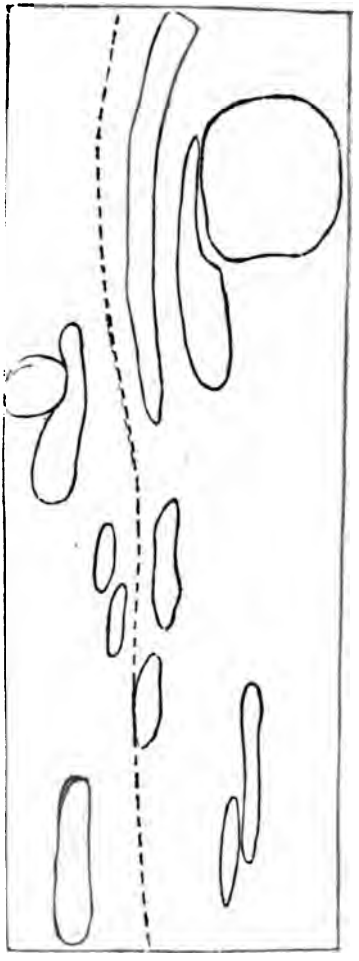
More than nine-tenths of the pebbles in the Wallingford conglomerates, are grey, somewhat granular, but often more or less hyaline quartz. White feldspar nodules are not uncommon. Quartz is sometimes disseminated through the feldspar, so as to form a sort of graphic granite. A few pebbles of distinct gneiss have been noticed. But it is not unusual for the micaceous cement to exhibit laminæ of feldspar, becoming, in fact, veritable gneiss; and perhaps the gneiss pebbles may all have thus originated. The most striking pebbles of feldspar, however, are seen in a finer variety of the rock, destitute of quartz pebbles, but showing small white rounded masses of feldspar, rarely over half an inch in diameter. We are of opinion that all the feldspar pebbles, as well as the narrow

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strips of gneiss, are the result of metamorphism; that is, the pebbles were changed in mineral constitution, and the gneiss actually formed, by metamorphic processes. But we shall recur to this subject again in the sequel.

Most of the pebbles are somewhat elongated in the direction of the strike on a horizontal surface, so as to give them an egg-shaped appearance. But where joints or other fissures have exposed the edges of the strata at right angles to the strike the elongation flattening and bending of the pebbles, are much more striking, as the following outline, fig. 6, will show. Yet even here, a few pebbles appear not to have been at all modified in form:—two such are shown on the drawing. They seem not to have been plastic as the others were.

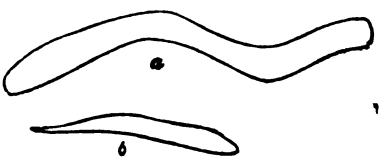
6.



Single pebbles sometimes show striking curvatures, as on fig. 7, where *a* represents a pebble ten inches long, and a little more than one inch wide, *b* shows a smaller one less curved, 5½ inches long, and half an inch wide.

A still more interesting case is shown in another boulder, a few feet long, represented imperfectly in fig. 8. Here the laminæ of the schists are bent considerably. On the inner side is a quartz pebble of considerable size, which is elongated and bent somewhat. But outwardly, the pebbles are so much flattened that they can hardly be distinguished from the quartzose laminæ of the rock. At the time this sketch was taken, we did not fully realize the important bearings it might have upon theory, and therefore we fear that it is not as minutely accurate as to every pebble, as could be desired. Still, the general facts above named are quite manifest, and these are all that are important.

7.



The preceding facts would justify some inferences additional to those drawn from the Newport rock. But we will first describe another locality on the east side of the Green mountains, where the metamorphic processes, begun at Newport and carried still

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farther at Wallingford, are completed in the most satisfactory manner.

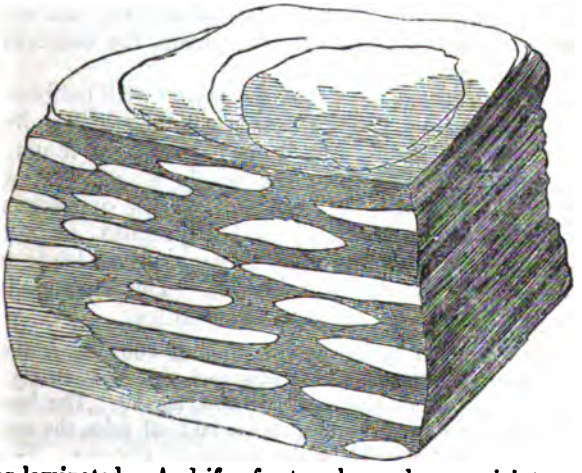
It is at Plymouth, along the west shore of Plymouth Ponds, most fully developed, perhaps, just where the ponds are separated by a mass of detritus, which was most probably the moraine of an ancient glacier, as will be described in our Report on the geology of Vermont.

8.



The schist, which here is decidedly talcose schist for the most part, and not far from some of the gold diggings, has an easterly dip; from 50° to 60°; and a direction a few degrees east of north. As the ledges crowd closely upon the road, a fine opportunity is presented of seeing the quartz pebbles that have not been much flattened on the exposed surfaces, having the aspect of a most decided conglomerate. Yet, if joints cross the rock, or if it be broken across, in the direction of the strike, the pebbles will for the most part, appear so flattened that they become almost len-

9.



ticular, or laminated. And if a fracture be made, or a joint occur, in a perpendicular direction, that is in the direction of the dip, the pebbles almost wholly disappear, or rather seem converted into the quartz laminæ of talcose schist. Both these facts are shown on fig. 9, which was copied

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from one of the specimens obtained at this locality. Looking at one of these edges, we should have no hesitation in referring the rock to a highly quartzose variety of talcose schist. But looking at the other edge, we should have no doubt that the quartz laminæ are merely flattened and elongated pebbles. So strange and unexpected a fact leads the geologist to suspect that he may be deceived; but hundreds of specimens force him to the conclusion that he is not mistaken.

The quartz in this rock, both in Wallingford and Plymouth is generally white, or a light gray, and though sometimes granular, it approaches much nearer the hyaline variety, in most instances. It seems to be quite pure silex, rather than a silicate. In a few instances we find pebbles of granite, which are also flattened.

The suggestion has been made that what I regard as pebbles may be concretions. But the following facts seem to me to show this position to be untenable. 1. We have no other example of concretions formed of hyaline or granular quartz. 2. Concretions are never, as these nodules are, drawn out into the laminæ of schists. 3. Siliceous concretions, such as chalcedony, formed by gelatinous silex, are banded; but these nodules show no concentric structure. 4. Some of them consist of granite, gneiss, &c., which certainly never form concretions. 5. If these nodules are concretions, so are the pebbles of quartz and granite found loose in modified drift; or rather, no line of distinction can be drawn between the concretions and the pebbles.

The thickness of the rock where the pebbles are indicated, is many hundred feet. Indeed, it may be much more, as I have not fully explored it. And if, as we suppose, the strata already described in connection with the conglomerate, are only that rock in an advanced state of metamorphism, the original thickness must have been very great.

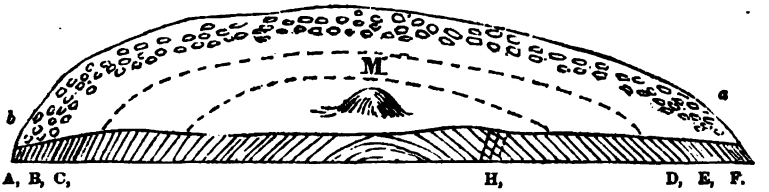
We have ascertained, also, that the layers with pebbles extend as far south as Ludlow, though nearly converted there into mica schist; nor can we doubt but it may be traced much farther south and north, perhaps even the whole length of the Green mountains. At any rate, its occurrence on the opposite sides of that mountain at Wallingford and Plymouth, at points not much different from east and west of each other, leads to some interesting suggestions and conclusions. The distance between these two points is about ten and a half miles.

Myself and son, aided by the Senior Class of 1861, in Amherst College, have recently, (October, 1860), traversed this line, mostly on foot, and obtained as the result, the section below, fig. 10. The base of the section is the sea level, and the heights are laid off from the same scale, (about 13,000 feet to the inch), as the horizontal distance. This makes the Green mountains, (1390 feet above the ocean at Mt. Holly), appear of very diminutive size. But it is a true representation, except that the mountain for the sake of distinctness is a little too high. On both the flanks of the mountain, the dips are quite distinct, (they were measured

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and the mean taken along the railroad from Ludlow to the summit as well as from the Plymouth Ponds). But in the central parts they are a good deal irregular. It will be seen that all the central portion of the mountain is gneiss of the peculiar kind known as the Green mountain gneiss. Above this lies, what has been called talcose schist, with which limestone is interstratified, and on the east side several beds of dark grey hyaline quartz, only a few feet thick. One of these beds, however, is snow-white. The upper part of the schist is the conglomerate already described, of a character so marked as not to be mistaken. At the west end we found several beds of limestone, but none of quartz. Beyond the conglomerate, however, and probably lying conformably upon it is an enormous development of granular quartz, which seems to have no counterpart on the east side of the mountain.

10.



In this section *a*, *b*, shows the present surface, *a* being Wallingford, and *b* Plymouth. From A to B we have the talcose conglomerate; from B to C, mainly gneiss with some schist, and at least three beds of limestone, from C to D, gneiss with several trap dykes at H, the summit level of the railroad; from D to E, gneiss with talcose schist and at least two beds of limestone, and several thin beds of quartz; from E to F, talcose conglomerate. This last rock, so distinct and peculiar, forms a good starting point for our reasoning. I think no geologist will doubt that it once mantled over the mountain with the subjacent strata as represented in the above section. True, we have not found all the subordinate beds of limestone and quartz to correspond on the two sides of the mountain. But there is a general correspondence. The beds of limestone, especially, may have extended originally over the arch of the mountain, although it is not common to find limestone beds as thin as these, with so great a lateral extension. As to the beds of quartz, if this be in nearly all cases a rock produced in the wet way, all we can say is, that circumstances may have been more favorable for its production on the east than on the west side of the crest of the mountain.

Taking this section as a fair representation of the Green mountains, several important inferences follow.

1. It shows the gneiss of the Green mountains, to form a great anticlinal fold not a synclinal fold, as some have supposed. 2. This gneiss underlies the talcose schist, the limestone, the quartz rock and the conglomerate. 3. All these latter rocks probably once mantled over the gneiss, though they have mostly disappeared from the eastern side, except the talcose schist. 4. We

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get an approximate idea of the amount of erosion from this part of the Green mountains. We have flattened down the curve described by the strata originally, more than perhaps we ought to do, yet it runs almost twice as high as Mansfield mountain, which is shown on the section at M, and is the highest point in the chain. The erosion at Mt. Holly cannot have been less than 8000 feet, which is nearly six times as great as the present height of the mountain at the summit level of the railroad. 5. We see here how the schists and gneiss may be formed out of conglomerate. This is perhaps the most important inference, and therefore it will be dwelt upon more fully in the sequel.

We proceed now to draw some inferences from the facts detailed respecting the Vermont conglomerates, additional to those already given. The Vermont localities teach the same lessons as those of Rhode Island, but we think they develop other conclusions.

1. They show, we think, that the elongating and flattening force in Vermont must have operated most energetically in the direction of the dip, whereas in Rhode Island, it was most powerful in the direction of the strike. In the latter case it was as if two men had taken hold of the ends of a plastic mass, and pulled it out horizontally; but in Vermont it is as if one had stood at the top of a steep hill, and the other at the bottom. This is evident from the fact that when we look at the edges of the rock laid bare along the line of the dip, we see little more than the flattened edges of the pebbles in the form of laminæ, but if laid bare along the line of strike we see the scattered and even lenticular ends of the pebbles, as shown in fig. 9, already given. The fact however, that the pebbles are lenticular on the basset edges of the strata, shows that the whole force was not exerted in the direction of the dip. They were a good deal flattened horizontally, but never so vertically.

2. We think we can get a glimpse in Vermont of the mode in which the force acted to elongate and flatten the pebbles. We refer to the bowlder shown in fig. 8, where it is obvious that the bending of the rock, if it was plastic could produce that effect, because the outer portions must be extended over wider and wider spaces. Hence, as in the figure, a pebble on the interior part, might be only moderately extended while the outer ones were stretched almost into mere laminæ.

Apply now this principle to fig. 10, which shows the manner in which, as we suppose, the strata were folded over the top of the Green mountains. The effect would be to stretch them out more in the direction of the curve, or dip, than at right angles to it; although the strain would spread them in that direction also, to some extent, and it may be that the irregularities that must have accompanied such great movements as the folding up of a

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mountain chain, would make the horizontal elongation in some places the greatest.

We do not assert that this explanation of the phenomena is the true one, but only that it shows one mode in which the process might have been performed. Whether any horizontal flexure can be found in the Rhode Island rock to explain the elongation there, we are unable to say, because the theory was not in our minds when we examined those rocks.

3. The facts detailed, disclose to us some of the modes in which the laminæ of the schists and of gneiss may have been produced. The first mode is by chemical agencies. Out of the cement of conglomerate these agencies have formed mica and talc, whose parallel structure was probably the result, mainly of pressure. We doubted for a time whether we could justly include gneiss among the rocks that may have originated from conglomerate; for we have not found as yet decided examples of pebbles in this rock. Yet so intimately connected with the conglomerate schists is the Green mountain gneiss, as the preceding details show,—so little, in fact, does it differ from the schists, that we cannot doubt but both originated from the same parent source. But the conglomerate at Wallingford affords still stronger evidence and shows us the modes in which the gneiss was produced from the conglomerate. Some of the elongated pebbles there are gneiss. But we doubt whether they were originally so; for quite often the cement is changed to gneiss. To effect this change it was only necessary that feldspar should be interpolated between the laminæ of mica or talc. And no one who has seen the specimens will imagine that it could have been introduced mechanically, by deposition, for example. The last way, or crystallization from solution, is the only other probable mode. Gneiss, perhaps, has been generally formed by such an interpolation of feldspar into the schists, and this may be the reason why we seldom, perhaps never, see pebbles in that rock. We do not yet despair, however, of finding pebbles in gneiss, now that we know how to look for them. Indeed, some varieties of it contain nodular elongated masses of feldspar interlaminated with mica which may perhaps have been originally pebbles chemically changed and elongated mechanically.

The second agency by which conglomerate has been converted into schists, is mechanical. By some force they have been flattened and elongated till they have become the quartzose laminæ of the schists. It is not probably possible for us to convey a very clear and complete idea of the evidence of this position. Would that our readers could, as we have done, visit the localities again and again and become familiar with the striking specimens there, by repeated and careful examination. From our own experience, it would not surprise us, if the conversion of the pebbles of con-

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glomerates into the laminæ of schists should be pronounced preposterous by able geologists. So the idea seemed to us at first, when the facts forced it upon our attention. But as the facts compelled us to give up our scepticism, so we think it will be with any candid mind. Looking at almost any specimen of the talcose conglomerate schist, on the edge corresponding to the dip (B fig. 9,) we should see nothing but alternating laminæ of quartz and talc, or mica, and pronounce it a good example of the rock which we have called, and which is generally called, talcose schist. But a fracture at right angles reveals the flattened pebbles (A fig. 9), and shows us that their edges are what we have regarded as laminæ. Let the process of flattening be carried a little farther, and no evidence will remain that they ever were pebbles. Who knows how extensively the process may have been thus carried through in the schists and gneiss of the Green mountains, and how large a part of them may once have been conglomerate? Our aim, however, is not to show the extent of the metamorphosis, but only to prove its occurrence on a large scale.

4. A fourth conclusion forced upon us by the facts is, that the chemical constitution of the pebbles has generally been altered in the process of metamorphism without obliterating their original mechanical character.

As has been repeatedly stated, most of the pebbles in the Vermont rock are quite pure quartz, having often more or less of a vitreous aspect. In fact it is nearly pure silex; and it is that form of silex which is absolutely insoluble in anything but hydrofluoric acid; nor can we suppose the presence of any heat high enough to melt it, without completely destroying the forms of the pebbles. Yet the evidence that they have been in a plastic state so as to be molded by pressure is too decided to be resisted. How then have they been softened?

Let us recur to the conglomerate at Newport. Most of the pebbles there are not pure quartz but rather silicates of such bases as alumina, magnesia, lime and iron. Now the silicates are soluble by water containing alkalies; and such quartz as is seen in the Vermont pebbles may be the residuum of the decomposition of the silicates, the bases being abstracted to form other compounds, the quartz is left.

This may be the most probable theory of the origin of quartz rock generally. Even if we suppose it produced from sandstone, we know of no other way in which it could have been formed; for nearly all the sandstones are silicates.

But suppose the silicates in the form of pebbles to be permeated by water containing alkalies, could their bases be abstracted without entirely destroying the form of the pebbles? We do not see why this could not be done, if the mass is kept in such a state by the water that the laws of chemical affinity

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should prevail, forming new compounds, and leaving the quartz behind. The chief effect upon the pebble would be to reduce its bulk, though we do find sometimes the cement so strongly adhering to the pebble, that it can hardly be separated so as to leave a smooth surface. The bases, we think, could be mostly used in forming the micaceous or talcose cement, and if there was a good deal of pressure upon the whole rock, as we may reasonably suppose, if the pebbles did shrink some, the cement would increase and the whole mass would be compacted together.

To sustain the position that the mineral constitution of pebbles in conglomerates is sometimes entirely changed without destroying their character as pebbles, we would refer to another kind of conglomerate which we have found along the eastern border of Vermont, and farther south in Massachusetts. This rock, so far as we know, has never been described in treatises on geology; but we know of four localities on the west side of Connecticut river, and its character and origin are quite obvious. We cannot here go into full details as to this rock, but shall mention only the facts that bear especially upon the point under consideration.

We define this rock as a conglomerate, with a cement of syenite, or granite, or as a syenite or granite containing pebbles, sometimes thickly and sometimes sparsely disseminated. We have found it in Whately, Mass., on Ascutney, and in Barnet, Vt. On the southeast point of Little Ascutney we find a conglomerate, or perhaps a breccia, which is made of fragments of silex and some mica, probably a sandstone with nearly pure quartz. On one side of this mass, it passes, without an intervening seam, into a porphyry, and this into granite, all forming one undivided ledge; so that the conclusion is forced upon us that the granite and porphyry have been formed out of the conglomerate. Most of the rock on Ascutney takes hornblende into its composition, and thus becomes syenite, and this abounds in black rounded masses, which are, for the most part, crystalline hornblende, with some feldspar, and which are probably pebbles transmuted. At Granby, the pebbles manifestly rounded, are either mica schist, or white almost hyaline quartz, just such as form the pebbles in the conglomerates at Wallingford and Plymouth, and the base is a fine-grained syenite, passing sometimes almost into mica schist. A pebble of hornblende schist is also sometimes seen.

In bowlders of this conglomerate found in Northampton, Mass., and probably derived from Whately, the most abundant pebbles are those of the brown sandstone, considerably metamorphosed and flattened. Those of hornblende schist are common. Sometimes they are merely crystalline hornblende, not generally laminated however, but mixed with some feldspar, and

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they may become syenite, and are frequently porphyritic by distinct crystals of feldspar. The cement is syenite, often more hornblendic than usual.

When the pebbles are highly crystallized, they become so incorporated with the matrix that it is difficult to separate them with a smooth surface, and if we are not mistaken, they pass insensibly into those rounded nodules chiefly hornblendic, so common in syenite, especially that of Ascutney. We think these are produced from the metamorphoses of pebbles which have become crystalline since they were formed into conglomerate. We find them, as we think, in all stages of the metamorphosis.

These facts certainly give great plausibility to the view which supposes granite and syenite to be often the result of the metamorphosis of stratified rock. But they afford a presumption, also, in favor of the position, that pebbles, which have been plastic for ages in the rocks, may have greatly changed their mineral constitutions without essentially altering their external form. This might certainly be thoroughly done if those pebbles were permeated by water containing in solution powerful chemical agents. Some of the ingredients might thus be abstracted from the pebbles and new ones supplied, if needed to form the new compounds.

In all the cases of pebbles in unstratified rocks described above, syenite has formed the matrix. But at the meeting of the American Association at Springfield, Prof. Hubbard of Dartmouth College exhibited a specimen of pure white granite from Warren in New Hampshire, in which there lay imbedded a rounded bowlder of hornblende rock, more than a foot in diameter, and easily separable from the granite. We had no doubt but that it was mechanically rounded, nor much doubt but that its mineral character had been changed since it was enveloped in granite. Hornblende bowlders in the drift are among the most infrequent of all rocks, because hornblende schist is very limited. But in the older metamorphic conglomerates, such nodules are the most common of all, and this fact furnishes the presumption of their metamorphic origin.

The facts which we have detailed respecting the occasional presence of feldspar pebbles in the Vermont conglomerates and especially of the occasional conversion of the cement into gneiss, are most probably examples of a change of mineral character during metamorphosis. It seems hardly possible to account for a cement of crystalline mica or talc, in any other way. But when we find feldspar interpolated between the laminæ, any other than a chemical origin appears improbable. We cannot therefore but regard feldspar in perhaps all cases in the crystalline rocks, as the result of metamorphism. Silicates probably furnished the ingredients, which being abstracted by hot water,

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left the excess of silica in the form of quartz, and forced the feldspar and mica to fill up the interstices. The feldspar which has converted the cement into gneiss, could have had no other origin and this fact in connection with all the rest which have been adduced, affords a presumption that feldspar in nearly all the crystalline rocks, stratified and unstratified, is a product of metamorphism.

We will add a few words as to other localities of conglomerates with flattened pebbles. The subject has opened upon us in its fullness so recently that we have not had time to visit others. But we happen to have specimens from Bernardston, Mass., in which the elongation and flattening are decided in a conglomerate micaceous schist connected with clay slate and quartz rock. The same is true to some extent in a like rock from Bellingham, Mass. Still more decided is it in bowlders of the conglomerate-syenite described above from North Hampton; as it is also in the same variety of rock on Little Ascutney. In fact we predict that this phenomenon will be found present in very many of the thoroughly metamorphic conglomerates, although not noticed by observers, because their attention was not called to it.

Less than a mile north of the conglomerate locality in Plymouth, Vt., on the east side of the pond, and nearly on the strike of the conglomerate, occurs a remarkable variety of marble in an interstratified bed several rods wide. It consists of a ground of dark limestone through which are disseminated numerous elongated masses from half an inch to six inches long, and from a quarter of an inch to an inch wide, of white, semicrystalline carbonate of lime. Their larger axes lie as nearly parallel to one another as those of the quartzose conglomerate. What their origin was I have scarcely ventured to conjecture. One naturally enquires, however, whether they may not be elongated organic remains, such as corals. At any rate, the enquiry may be worthy of consideration, whether they are not masses elongated by the same force that has acted on the not far distant conglomerate. This idea did not occur to me when in the vicinity, and therefore I did not go to determine the point. If there be any foundation for this suggestion, we should expect that the longer axes of these nodules would correspond more nearly with the dip than with the strike. I have not the slightest recollection whether it is so.

The chief interest in the facts and conclusions in this paper, lies in the light they cast upon metamorphism. We had indeed felt that there was a good deal of probability in the general doctrines of metamorphism advanced by able men. But never before have we had the various steps of the process brought directly under our eyes, and so distinctly as to confound our scepticism and challenge our belief. Instead of any prejudices in favor of the conclusions to which we have been brought, our prepossessions have been the other way. But we could not resist evidence so clear, and we find that our new views greatly illustrate the subject of metamorphism. It seems to us difficult to conceive how geologists can avoid the conclusions we have presented, if

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they will visit and study the localities we have pointed out. We have indeed, specimens from them all, in the Amherst Cabinets, to the amount of several hundred pounds, and they illustrate nearly all the points we have brought out. But we advise gentlemen not to substitute an inspection of these, for the more satisfactory exhibitions in the mountains.

Amherst College, Nov. 1, 1860.

NOTE.—A brief and imperfect summary of the preceding facts and arguments having been presented by me last autumn before the Boston Natural History Society, Dr. Charles T. Jackson, who presided at the meeting, expressed his dissent from my views as to the manner in which the pebbles had been flattened and distorted, and his conviction that they had either been worn into these shapes by water, previous to aggregation, or that some of these were concretions. At a subsequent meeting, Prof. Wm. B. Rogers expressed similar views, which appeared in the published proceedings of the society.* I do not understand these distinguished geologists to have made up their minds very decidedly on the subject, especially as they have not visited the Vermont localities. But objections suggested by gentlemen of such large geological experience, deserve serious consideration.

I have already stated my objections to the theory which they adopt as to the forms of the pebbles. Prof. Rogers suggests as an objection to my views, that the pressure which I suppose to have flattened and distorted the pebbles, has not produced cleavage. But this conglomerate is not a rock in which cleavage is ever found. It is a foliated, or schistose rock. It has joints in it, such as prove very clearly that it was once in a state more or less plastic; but these (the most perfect ones especially,) cross the laminæ at nearly right angles, and could never have been produced by pressure. It is a fact, however, that some of the larger pebbles, particularly at their extremities, do show the commencement of a schistose structure, probably the result of pressure. Yet the facts do not require us to suppose the pressure on this rock to have been of the most powerful kind. In some cases indeed, as at Plymouth, the pebbles are compressed into laminæ, but in general, they are only moderately flattened, and sometimes not at all. If only moderately plastic, such effects could not have required a very enormous force.

Another objection is, that the compression has not distorted the fossil Lingulæ found in the pebbles on Taunton river, and at Newport. But I am not aware that the pebbles in the conglomerate of Taunton river, have been compressed and elongated; nor have they been, in but a part of that around Newport.

* See under GEOLOGY in this number the remarks of Prof. Rogers.

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Whether they have been in the particular pebbles containing the fossils, I am unable to say.

A third objection rests upon the fact that some of the pebbles have scarcely been flattened at all, and their longer axes cross the foliation;—though I do not myself recollect to have seen any where the position was much awry. But some of them, on account of their composition, may have been scarcely at all plastic, or had such a position that the pressure affected them but slightly. We certainly ought to expect such cases.

I have been led, of late, to a reperusal of the able papers that have appeared for several years past in the English journals, on cleavage, compressed and distorted fossils, and particles of slate, by Sharpe, Sorby, Tyndall, Scrope, Scheerer, and Haughton. The result is, a conviction that the facts which I have given respecting the conglomerates, are only another phase of the phenomena described by these eminent geologists. If the facts they adduce prove the elongation and expansion of slate, limestone and fossils, as is generally conceded, although proved mainly by the microscope, why should we think it strange that the like effects may have been produced upon conglomerates, so as to show themselves on a large scale, and to unaided vision? The manner in which the veteran geologist, Scrope, supposes gneiss and mica schist may have been formed out of granite, (which he has illustrated by figures, *Phil. Magazine*, vol. li, p. 196), whatever we may think of the hypothesis, corresponds very nearly with some of my suppositions, or rather *facts*, as to the conversion of conglomerates into schists. And the ideas of most of these writers as to the former plastic condition of most of the rocks, correspond with those which I have expressed. If I am wrong, then, I have the consolation of being in good company.

Prof. Tyndall, in his recent work on the Alpine Glaciers, has referred to an interesting specimen in London, analogous to the conglomerates of Rhode Island and Vermont.

In the museum of the Government school of Mines, he says, "we have a collection of quartz stones placed there by Mr. Salter, and which have been subjected to enormous pressure, in the neighborhood of a fault. These rigid pebbles, have in some cases, been squeezed against each other so as to produce a mutual flattening and indentation. Some of them have yielded along planes passing through them, as if one half had slidden over the other; but the reattachment is very strong. Some of the larger stones, moreover, which have endured pressure at a particular point, are fissured radially around the point. In short, the whole collection is a most instructive example of the manner and extent to which some of the most rigid substances

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in nature can yield on the application of a sufficient force.—(*Glaciers of the Alps*, p. 404, Amer. Ed.)

Though these specimens are not so definitely described as we could wish, we presume they are conglomerates with flattened quartz pebbles, like those in Rhode Island and Vermont. Our objections to Prof. Tyndall's hypothesis, which imputes the effect wholly to the mechanical compression of solid quartz, are as follows:

1. The compression of pure quartz pebbles, such as some of those in Rhode Island, and most of those in Vermont, would break and crush them, nor have we any reason to suppose that the fragments could be reconstructed so as to form hyaline masses, without fissures. There is no fluid, as in ice, to produce regelation; nor could the particles be brought near enough for molecular attraction, without being crushed into the finest powder, by such a pressure as the facts show not to have been exerted upon the conglomerates.

2. The compressing force has not been great enough to destroy except partially, the form of the pebbles. It has not crushed but only moulded them, except that now and then, one has been fractured. If it had been powerful enough to compress and distort solid quartz and to reunite its particles, it must have destroyed all marks of a mechanical origin in the pebbles.

3. There is evidence, as we have tried to show, in the preceding discussion, that many of the pebbles, especially in the Vermont rocks, have undergone a chemical change; that certain silicates have been abstracted from them, leaving the excess of silica in the form of quartz. This, of course, would require such a degree of plasticity, as to enable water to permeate the mass.

March 20th, 1861.

ART. XXXV.—*On some points in American Geology;* by T. STERRY HUNT, F.R.S., of the Geological Survey of Canada.

THE recent publication of two important volumes on American geology seems to afford a fitting occasion for reviewing some questions connected with the progress of geological science, and with the history of the older rock formations of North America. The first of these works is the third volume of the Palæontology of New York by James Hall; we shall not attempt the task of noticing the continuation of this author's labors in the study of organic remains, labors which have by common consent placed him at the head of American palæontologists, but we have to call attention to the introduction to this third volume, where in about a hundred pages Mr. Hall gives us a clear and admirable

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summary of the principal facts in the geology of the United States and Canada, followed by some theoretical notions on the formation of mountain chains, metamorphism and volcanic phenomena, where these questions are discussed from a point of view which we conceive to be of the greatest importance for the future of geological science. A publication of this introduction in a separate form, with some additions, would we think be most acceptable to the scientific public.

The other work before us is Prof. H. D. Rogers' elaborate report on the geology of Pennsylvania, giving the results of the Survey of that State for many years carried on under his direction, and embracing a minute description of those grand exhibitions of structural geology, which have rendered that State classic ground for the student. The volumes are copiously illustrated with maps, sections and figures of organic remains, and the admirable studies on the coal fields of Pennsylvania and Great Britain add much to its value.

The oldest series of rocks known in America is that which has been investigated by the officers of the Geological Survey of Canada, and by them designated the Laurentian system. It is now several years since we suggested that these rocks are the equivalents of the oldest crystalline strata of western Scotland and Scandinavia.* This identity has since been established by Sir R. I. Murchison in his late remarkable researches in the northwestern Highlands, and he has adopted the name of the Laurentian system for these ancient rocks of Ross, Sutherland, and the Western Islands, which he at first called fundamental gneiss.† These are undoubtedly the oldest known strata of the earth's crust, and therefore offer peculiar interest to the geologist. As displayed in the Laurentide and Adirondack mountains, they exhibit a volume which has been estimated by Sir William Logan to be equal to the whole palæozoic series of North America in its greatest development. The Laurentian series consists of gneiss, generally granitoid, with great beds of quartzite, sometimes conglomerate, and three or more limestone formations, (one 1000 feet in thickness) associated with dolomites, serpentines, plumbago, and iron ores. In the upper portion of the series an extensive formation of rocks, consisting chiefly of basic feldspars without quartz and with more or less pyroxene, is met with. The peculiar characters of these latter strata, not less than the absence of argillites and talcose and chloritic schists, conjoined with various other mineralogical characteristics seem to distinguish the Laurentian series throughout its whole extent, so far as yet studied, from any other system of crystalline strata. It

* Esquisse Géologique du Canada, 1855, p. 17.
† Quar. Journal Geol. Society, vol. xv, 353; xv, 215.

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appears not improbable that future researches will enable us to divide this series of rocks into two or more distinct systems.

Overlying the Laurentian series on Lake Huron and Superior, we have the Huronian system, about 10,000 feet in thickness, and consisting to a great extent of quartzites, often conglomerate, with limestones, peculiar slaty rocks, and great beds of diorite, which we are disposed to regard as altered sediments. These constitute the lower copper-bearing rocks of the lake region, and the immense beds of iron ore at Marquette and other places on the south shore of Lake Superior have lately been found by Mr. Murray to belong to this series, which is entirely wanting along the farther eastern outcrop of the Laurentian system. This Huronian series appears to be the equivalent of the Cambrian sandstones and conglomerates described by Murchison, which form mountain masses along the western coast of Scotland, where they repose in detached portions upon the Laurentian series.

Besides these systems of crystalline rocks, the latter of which is local and restricted in its distribution, we have along the great Appalachian chain, from Georgia to the Gulf of St. Lawrence, a third series of crystalline strata, which form the gneissoid and mica slate series of most American geologists, the hypozoic group of Prof. Rogers, consisting of feldspathic gneiss, with quartzites, argillites, micaceous, epidotic, chloritic, talcose and specular schists, accompanied with steatite, diorites and chromiferous ophiolites. This group of strata has been recognized by Safford in Tennessee, by Rogers in Pennsylvania, and by most of the New England geologists as forming the base of Appalachian system, while Sir William Logan, Mr. Hall, and the present writer have for many years maintained that they are really altered palæozoic sediments, and superior to the lowest fossiliferous strata of the Silurian series. Sir William Logan has shown that the gneissoid ranges in Eastern Canada have the form of synclinals, and are underlaid by shales which exhibit fossils in their prolongation, while his sections leave no doubt that these ranges of gneiss, with micaceous, chloritic, talcose and specular schists, epidosites, quartzites, diorites and ophiolites, are really the altered sediments of the Quebec group, which is a lower member of the Silurian series, corresponding to the Calciferous and Chazy formations of New York, or to the Primal and Auroral series of Pennsylvania. Prof. Rogers indeed admits that these are in some parts of Pennsylvania metamorphosed into feldspathic, micaceous and talcose rocks, which it is extremely difficult to distinguish from the hypozoic gneiss, which latter, however, he conceives to present a want of conformity with the palæozoic strata.

To this notion of the existence of two groups of crystalline rocks similar in lithological character but different in age, we

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have to object that the hypozoic gneiss is identical with the Green Mountain gneiss, not only in lithological character, but in the presence of certain rare metals, such as chrome, titanium, and nickel which characterise its magnesian rocks; all of these we have shown to be present in the unaltered sediments of the Quebec group, with which Sir William Logan has identified the gneiss formation in question. Besides which the lithological and chemical characters of the Appalachian gneiss are so totally distinct from the crystalline strata of the Laurentian system, with which Prof. Rogers would seem to identify them, that no one who has studied the two can for a moment confound them. Prof. Rogers is therefore obliged to assume a new series of crystalline rocks, distinct from both the Laurentian and Huronian systems, but indistinguishable from the altered palæozoic series, or else to admit that the whole of his gneissic series in Pennsylvania is, like the corresponding rocks in Canada, of palæozoic age.* We believe that nature never repeats herself without a difference, and that certain variations in the chemical and mineralogical constitution of sediments mark successive epochs so clearly that it would be impossible to suppose the formation in adjacent regions of a series of crystalline schists like those of the Alleghanies contemporaneous with the sediments which produced the Laurentian system. We have elsewhere indicated the general principles upon which this notion of a progressive change in the composition of sediments is based, and shown how the gradual removal of alkalies from aluminous rocks has led to the formation of argillites, chloritic and epidotic rocks, at the same time removing carbonic acid from the atmosphere, while the resulting carbonate of soda by decomposing the calcareous and magnesian salts of the ocean, furnished the carbonates for the formation of limestones and dolomites, at the same time generating sea salt.†

Closely connected with these chemical questions is that of the commencement of life on the earth. The recognition beneath the Silurian and Huronian rocks, of 40,000 feet of sediments analogous to those of more recent times, carries far back into the

* Dr. Bigsby in 1824 described an extensive tract of gneissoid rocks on Rainy Lake and Lake Lacroix, north of Lake Superior. The general course of the strata he states to be "from N.W. to N. by W., with a corresponding easterly dip;" but he elsewhere speaks of the gneiss as running (dipping?) E.N.E. This gneiss often contains beds and disseminated grains of hornblende, and passes in some places into micaceous, chloritic and greenstone slates, and syenite. Staurotide is abundant in the mica schists, and octahedral iron occurs in the chloritic slates. A porphyritic granite containing beryl is also met with in this region. This gneiss is regarded by Dr. Bigsby as belonging "to transition rocks, from its constant proximity to red sandstone, the oldest organic limestone, and trap." (Am. Jour. Sci. (1), viii, 61). The lithological and mineral characters of these crystalline strata seem to be distinct from those of the Laurentian system, and to resemble those of the Appalachians. Too much praise cannot be ascribed to Dr. Bigsby for his early and extensive observations on the geognosy and mineralogy of British North America.

† This Journal [2], xxv, 102, 445, xxx, 133; and Quar. Jour. Geol. Soc., xv, 488.

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past the evidence of the existence of physical and chemical conditions, similar to those of more recent periods. But these highly altered strata exclude, for the most part, organic forms, and it is only by applying to their study the same chemical principles which we now find in operation that we are led to suppose the existence of organic life during the Laurentian period. The great processes of deoxydation in nature are dependent upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago, and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxyd of iron is partially reduced and dissolved from great masses of sediments, to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations, and the extensive beds of iron ore hundreds of feet thick which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but as we may suppose, to organic matters, which but for the then great diffusion of iron oxyd in conditions favorable for their oxydation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet in the Laurentian strata.

All these conditions lead us then to conclude to the existence of an abundant vegetation during the Laurentian period, nor are there wanting evidences of animal life in these oldest strata. Sir William Logan has described forms occurring in the Laurentian limestone which cannot be distinguished from the silicified specimens of *Stromatopora rugosa* found in the Lower Silurian rocks. They consist of concentric layers made up of crystalline grains of white pyroxene in one case and of serpentine in another, the first imbedded in limestone and the second in dolomite; we may well suppose that the result of metamorphism would be to convert silicified fossils into silicates of lime and magnesia. The nodules of phosphate of lime in some beds of the Laurentian limestones also recall the phosphatic coprolites which are frequently met with in Lower Silurian strata, and are in the latter case the exuviæ of animals which have been fed upon *Lingula*, *Orbicula*, *Conularia* and *Serpulites*, the shells and tubes of which we have long since shown to be similar in composition to the bones of vertebrates.* So far therefore from looking upon the base of the Silurian as marking the dawn of life upon our planet, we see abundant reasons for supposing that organisms, probably as varied and abundant as those of the

* Logan and Hunt, Amer. Jour. Sci. [2], xvii, 235.

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palæozoic age, may have existed during the long Laurentian period.

Along the northern rim of the great palæozoic basin of North America the Potsdam sandstone of the New York geologists is unquestionably the lowest rock from below Quebec to the Island of Montreal, and thence passing up the valley of Lake Champlain and sweeping round the Adirondack mountains, until it reënters Canada and soon disappears to the north of Lake Ontario, where the Birdseye and Black River limestones repose directly upon the Laurentian rocks, and furthermore overlie the great Lake Superior group of slates and sandstones, which reposing on the unconformable Huronian system, constitute the upper copper-bearing rocks of this region. This Lake Superior group, as Sir William Logan remarks, may then include the Potsdam, Calciferous and Chazy, and thus be equivalent in part to the Quebec group hereafter to be described.

Passing westward into the Mississippi valley we again find a sandstone formation, which forms the base of the palæozoic series, and is considered by Mr. Hall to be the equivalent of the Potsdam. Here it occasionally exhibits intercalated beds of silico-argillaceous limestone, in which occur abundant remains of trilobites of the genera *Dikellocephalus*, *Menocephalus*, *Arionellus*, and *Conocephalus*. Passing upwards this sandstone is succeeded by the Lower Magnesian limestone, which is the equivalent of the Calciferous sand-rock of New York, and in Missouri, where it is the great metalliferous formation, alternates several times with a sandstone, constituting the Magnesian Limestone series, which in Missouri attains a thickness of 1300 feet. The same thing is observed to a less degree in Wisconsin and Iowa; throughout this region the higher beds of the Potsdam sandstone are often composed of rounded oolitic granules, and the beds of passage are frequently of such a character as to lead to the conclusion that they have been deposited from silica in solution, and are not mechanical sediments.* For a discussion of some facts with regard to the chemical origin of many silicious rocks, see this Journal, [2], xviii, 381.

Evidences of disturbance during the period of its deposition are to be found in the brecciated beds, sometimes fifty feet in thickness, which occur in the Calciferous sandrock of the northwest, and are made of the ruins of an earlier sandstone. In Missouri, the Birdseye and Black River limestones repose directly upon the Lower Magnesian limestone, while farther north, a sandstone intervenes, occupying the place of the Chazy limestone.

* See Mr. Hall's Introduction, to which we are indebted for many of these facts regarding the formation of the west, and also the Reports of the Geological Survey of Missouri.

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The Potsdam sandstone of the St. Lawrence valley, has for the most part the character of a littoral formation, being made up in great part of pure quartzose sand, and offering upon successive beds, ripple and wind marks, and the tracks of animals. Occasionally it includes beds of conglomerate, or as at Hemmingford, encloses large rounded fragments of green and black shale; it also exhibits calcareous beds apparently marking the passage to the succeeding formation, which although called a Calciferous sandrock, is for the most part here, as in the west, a magnesian limestone, often geodiferous, and including calcite, pearl spar, gypsum, barytes and quartz. Sir William Logan had already shown that the fauna of the Potsdam and Calciferous in Canada are apparently identical, (Can. Nat., June, 1860; This Journal, [2], xxxi, 18), and Mr. Hall has arrived at the same conclusion with regard to the more extended fauna of these formations in the valley of the Mississippi, so that these two may be regarded as forming but one group. While in the west *Dikellocephalus* occurs both in the lower sandstones and the magnesian limestones, *Conocephalus minutus*, found in the Potsdam on Lake Champlain, and identified by Mr. Billings, has lately been detected by him in specimens from the sandstones of Wisconsin with *Dikellocephalus*, which genus has there been found to pass upwards into the magnesian limestones. On the other hand, the sandstones of Bastard in Canada, having the characters of the Potsdam, contain *Lingula acuminata* and *Ophileta compacta*, species regarded as characteristic of the Calciferous, together with two undescribed species of *Orthoceras*, and in another locality a *Pleurotomaria* resembling *P. Laurentina*. The researches of Mr. Billings have extended the fauna of the Calciferous in Canada to forty-one species, and the succeeding Chazy formation to 129 species. The thickness of this latter division in the St. Lawrence valley is about 250 feet, and it includes in its lower part about fifty feet of sandstones with green fucoidal shales and a bed of conglomerate. The Calciferous has a thickness of about 300 feet, while the Potsdam may be estimated at not far from 600 feet.

We have then seen that along the northeastern outcrop of the great American basin in Canada and New York, the base of the Palæozoic series is represented by less than 1000 feet of sandstones and dolomites, reposing directly upon the Laurentian system. A very different condition of things is, however, found in the more central parts of the basin. According to Prof. Rogers, the older Primal slates, which form the base of the palæozoic system, attain in Virginia a thickness of 1200 feet, and are succeeded by 300 feet of Primal sandstone marked by *Scolithus*, which he considers the Potsdam, followed by the upper Primal slates, consisting of 700 feet of greenish and brownish talco-argillaceous shales with fucoids. To these succeed his

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Auroral division, consisting of sixty feet or more of calcareous sandstone, the supposed equivalent of the Calciferous sandrock, followed by the Auroral limestone, which is magnesian, and often argillaceous and cherty in the upper beds. Its thickness is estimated at from 2500 to 5500 feet, and it is supposed by Rogers to include the Chazy and Black River limestones, while the succeeding Matinal division exhibits first, from 300 to 500 feet of limestone, (Trenton), secondly, 300 to 400 feet black shale, (Utica), and thirdly, 1200 feet of shales with red slates and conglomerates, (Hudson River Group), thus completing the Lower Silurian series.

In Eastern Tennessee, Mr. Safford describes, (1st.) on the confines of North Carolina, a great volume of gneissoid and micaceous rocks similar to those of Pennsylvania, succeeded to the west by (2nd.) the Ococee conglomerates and sandstones, with argillites, chloritic, talcose and micaceous slates, and occasional bands of limestone, all dipping, like the rocks of the 1st division, to the S.E. In the 3d place we have the Chilhowee sandstones and shales, several thousand feet in thickness, including near the summit beds of sandstone with *Scolithus*, and considered by Mr. Safford the equivalent of the Potsdam. (4th.) The Magnesian limestone and shale group, also several thousand feet thick, and divided into three parts; first a series of fucoidal sandstones approaching to slates and including bands of magnesian limestone; second, a group of many hundred feet of soft brownish, greenish, and buff shales, with beds of blue oolitic limestone, which as well as the shales, contain trilobites. Passing upward these limestones become interstratified with the third sub-division, consisting of heavy bedded magnesian limestone, more or less sparry and cherty near the summit. The limestones of Knoxville belong to this group, which with the 3d or Chilhowee group is designated by Mr. Safford as Cambrian, corresponding to the Primal and Auroral of Rogers, or to the Potsdam or Calciferous sandrock, with the possible addition of the Chazy, being equivalent to the great Magnesian limestone series of Prof. Swallow of Missouri. To these strata succeed Safford's 5th formation, consisting of limestones, the equivalents of the Black River, Trenton and higher portions of the Lower Silurian.

In Eastern Canada we find a group of strata similar to those described by Rogers and Safford, and distinguished by Sir William Logan as the Quebec group. It has for its base a series of black and blue shales, often yielding roofing slates, succeeded by grey sandstones and great beds of conglomerate, with dolomites and pure limestones, often concretionary and having the character of travertines. These are associated with beds of fossiliferous limestones, and with slates containing compound graptolites, and

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are followed by a great thickness of red and green shales, often magnesian, and overlaid by 2000 feet of green and red sandstone, known as the Sillery sandstone, the whole from the base of the conglomerate, having a thickness about 7000 feet. These red and green shales resemble closely those at the top of the Hudson River group, and the succeeding sandstones are so much like those of the Oneida and Medina formations, that the Quebec group was for a long time regarded as belonging to the summit of the Lower Silurian series, the more so by a great break and upthrow to the S.E., the rocks of this group are made to overlap the Hudson River formation. "Sometimes it may overlie the overturned Utica formation, and in Vermont, points of the overturned Trenton appear occasionally to emerge from beneath the overlap."* This great dislocation is traceable in a gently curving line from near Lake Champlain to Quebec, passing just north of the fortress; thence it traverses the island of Orleans, leaving a band of higher strata on the northern part of the island, and after passing under the waters of the Gulf, again appears on the main land about eighty miles from the extremity of Gaspé, where on the north side of the break, we have as in the island of Orleans, a band of Utica or Hudson River strata. To the south and east of this line the rocks of the Quebec group are arranged in long, narrow, parallel, synclinal forms, with many overturn dips. These synclinals are separated by dark gray and black shales, with limestones, hitherto regarded as of the Hudson River age, but which are perhaps the deep-sea equivalent of the Potsdam.

The presence of conglomerates and sandstones, alternating with great masses of fine shales, indicates a period of frequent disturbances, with elevations and depressions of the ocean's bottom, while the deposits of dolomite, magnesite, travertine and highly metalliferous strata show the existence of shallow water, lagoons and springs over a great area and for a long period between the formation of the upper and lower shales. We may suppose that while the Potsdam sandstone was being deposited along the shores of the great palæozoic ocean, the lower black shales were accumulating in the deeper waters, after which an elevation took place, and the magnesian strata were deposited, followed by a subsidence during the period of the upper shales and Sillery sandstones.

Associated with the magnesian strata at Point Levi and in several other localities in the same horizon of the Quebec group, an extensive fauna is found, of which 137 species are now known, embracing more than 40 new species of graptolites, which have been described by Mr. James Hall in the report of

* See Sir William Logan's letter to Barrande, Canadian Naturalist for Jan. 1861, and this volume, 261.

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the Geological Survey of Canada for 1857, and thirty-six species of trilobites described by Mr. Billings in the Canadian Naturalist for August, 1860. These species are as yet distinct from anything found in the Potsdam below or the Birdseye and Black River above; although the trilobites recall by their aspect those found by Owen in the Lower Sandstone of the Mississippi. Seven species alone out of this fauna have been identified with those known in other formations, and of these one is Chazy, while six belong to the Calciferous, to which latter horizon Mr. Billings considers the Quebec group to belong. The Chazy has not yet been identified in this region, unless indeed it be represented in some of the upper portions of the Quebec group. The Calciferous sandrock is wanting along the north side of the St. Lawrence valley from near Lake St. Peter to the Mingan Islands, but at Lorette behind Quebec, at the foot of the Laurentides, the Birdseye limestone is found reposing conformably upon the Potsdam sandstone.

It is not easy to find the exact horizon of the Potsdam sandstone among the black shales which underlie the Quebec group. The *Scolithus* of Rogers' Primal sandstone, and of the summit of Safford's 3d or Chilhowee formation is identical with that found in the quartz rock at the western base of the Green mountains, and figured by Mr. Hall in the 1st volume of the Palæontology. It is however distinct from what has been called *Scolithus* in the Potsdam of Canada. The value of this fossil as a means of identification is diminished by the fact that similar marks are found in sandstones of very different ages. Thus a *Scolithus* very like that of the St. Lawrence valley occurs in the sandstone of Lake Superior and in the Medina sandstone, while in Western Scotland, according to Mr. Salter, the two quartzite formations above and below the Lower Silurian limestones of Chazy age are alike characterized by these tubular markings, which are regarded by him as produced by annelids or sea-worms. We find however in shales which underlie the Quebec group at Georgia in Vermont, trilobites which were described by Mr. Hall in 1859 as belonging to the genus *Olenus*, a recognized primordial type; he has since erected them into a new genus. Again at Braintree in Eastern Massachusetts occur the well known *Paradoxyds* in an argillaceous slate. These latter fossils Mr. Hall suggests probably belong to the same horizon as certain slaty beds in the Potsdam sandstone, or perhaps even at the base of this formation. (Introduction, page 9.) In this connection we must recall the similar shales of Newfoundland, in which Salter has recognized trilobites of the same genus. These shales containing *Paradoxyds*, like those underlying the Quebec group, thus appear to belong to the Primordial zone, and are to be regarded as the equivalents of the Potsdam sandston e

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which both in Lake Champlain and in the Mississippi valley is characterized by primordial types. The intermingling of Potsdam and Calciferous forms to which we have already alluded, seems however to show that it will be difficult to draw any well defined zoological horizon between the different portions of these lower rocks, which at the same time offer as yet no evidence of any fauna lower than that of the Potsdam. So that we regard the whole Quebec group with its underlying Primordial shales as the greatly developed representative of the Potsdam and Calciferous (with perhaps the Chazy), and the true base of the Silurian system.

The Quebec group with its underlying shales is no other than the Taconic system of Emmons. Distinct in its lithological characters from the Potsdam and Calciferous formations as developed on Lake Champlain, Mr. Emmons was led to regard these strata as belonging to a lower or sub-Silurian group. We have however shown that the palæontological evidence afforded by this formation gives no support to such a view. To Mr. Emmons is however undoubtedly due the merit of having for a long time maintained that the Taconic hills are composed of strata inferior to the Trenton limestones, brought up into their present position by a great dislocation, with an upthrow on the eastern side. We would not object to the term Taconic if used as indicating a subdivision of the Lower Silurian series, but as the name of a distinct and sub-Silurian system it can no longer be maintained. The Quebec group evidently increases in thickness as we proceed toward the south, and the calcareous parts of the formation are more developed. In 1859, I visited in company with Mr. A. D. Hager the marble quarries of Rutland and Dorset, in Vermont. The latter occur in a remarkable synclinal mountain of nearly horizontal strata of marble and dolomite, capped by shales, and attaining a height of 2700 feet above the railway station at its base. I then identified these marbles with the limestones of the Quebec group, considering them to be beds of chemically precipitated carbonate of lime or travertine, and not limestones of organic origin.

The existence of great dislocations in the Appalachian chain is amply illustrated in the sections of Prof. Rogers, and in those given by Safford in Eastern Tennessee, where by the aid of fossils it becomes comparatively easy to trace them. See the Map accompanying his *Geographical Reconnaisance of Tennessee*, 1855; where the magnesian limestones of formation IV, are shown to be not only brought up on the east against the Upper Silurian and Devonian, but even to overlap the black shales at the base of the Carboniferous system. It is remarkable to find that as early as 1822, the idea of a great dislocation of this nature in Eastern New York was maintained by Mr. D. H. Barnes in his description of Canaan mountain. (This Journal, [1], v, pp. 15–18).

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To the southeast of this great fault in Canada we have as yet no evidence of Lower Silurian strata higher than those of the Quebec group. At the eastern base of the Green mountains, we find limestones of upper Silurian and Devonian age reposing unconformably upon the altered strata of the Quebec group, themselves also having undergone more or less alteration. Immediately succeeding are the chiastolite and mica slates of Lake St. Francis, which as we have long since stated are probably also of Upper Silurian age.

The White mountains as we suggested in 1849, (this Journal, [2], ix, 19), are probably, in part at least, of Devonian age, and are the representatives of 7000 feet of Devonian sandstone observed by Sir William Logan in Gaspé. Mr. J. P. Lesley has more recently, after an examination of the White mountains, shown that they possess a synclinal structure, and has adduced many reasons for regarding them as of Devonian age. (Amer. Mining Journal, Jan. 1861, p. 99).

It will be seen from what has been previously said that we look upon the 1st and 2d divisions described by Mr. Safford in Eastern Tennessee, as corresponding to the hypozoic series of Rogers and to the Green mountain gneissic formation, which instead of being beneath the Silurian series, is really a portion of the Quebec group more or less metamorphosed, so that we recognize nothing in New England or southeastern Canada lower than the Silurian system, nor do we at present see any evidence of older strata, such as Laurentian or Huronian, in any part of the Appalachian chain. The general conclusions which we have previously expressed with regard to the lithological, chemical and mineral relations of the Green mountain rocks remain unchanged. (This Journal [2], ix, 12).

The remarkable parallelism between the rocks of Western Scotland and Canada has already been shown in the existence of the Laurentian, and Cambrian (Huronian) systems, overlaid by quartzites containing *Scolithus*, to which succeed limestones containing a numerous fauna, identified by Mr. Salter with that of the Chazy limestone. These strata, with an eastward dip, are covered by other quartzites and limestones, to which succeeds the great gneissoid formation of the western Highlands, consisting of feldspathic, chloritic, micaceous, and talcose schists resembling closely the gneissoid rocks of the Green mountains, and including the chromiferous ophiolites of Perthshire, Banff and the Shetland Isles.

This gneissoid series was by Prof. Nicol suggested to be the older or Laurentian gneiss brought up by a dislocation on the east of the Silurian limestones, but Sir Roderick Murchison, with Messrs. Ramsay and Harkness, has shown not only from the differences in lithological character, but from actual sections, that the eastern

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gneissoid series is made up of altered strata newer than the Silurian limestones.* Thus in geological structure and age, not less than in lithological and mineralogical characters, the rocks of the western Highlands are the counterparts of the Laurentian and Silurian gneiss formations, as seen in the Laurentides and Adirondacks, and in the Green mountains. The same parallelism may be extended by Scandinavia, (where Kjerulf and Forbes have shown much of the crystalline gneiss to be of Silurian age,) marking as it would seem the outer edge of a vast Silurian basin, which may be followed in the other direction across the Atlantic to the Gulf of Mexico. We also remark in Great Britain as in America, that whereas the northern outcrop of the palæozoic basin offers at its base only a series of quartzose sandstones reposing upon the Laurentian system and characterized by fucoids and *Scolithus*, we find further south in England an immense development of shales, sandstones and conglomerates, which form the base of the Silurian system and correspond to the Primordial zone and the Quebec group.

We have said that upon Lake Huron and Superior the sandstones of the upper copper-bearing rocks are the equivalents of the Quebec group. The clear exposition of the question by Mr. J. D. Whitney in the Mining Journal for 1860 (p. 435) left little more to be said, but the sections made last year by Mr. Alex. Murray of the Canadian Geological Survey place the matter beyond all doubt. On Campment d'Ours, a small island near St. Joseph's, the sandstones of Sault St. Mary are seen reposing horizontally upon the upturned edges of the Huronian rocks, and overlaid by limestones which contain in abundance the fossils of the Black River and Birdseye divisions. The only fossil as yet found in these sandstones is a single *Lingula* from near Sault St. Mary, which may be either of Potsdam or Chazy age. The sandstones in question form the upper member of a series of strata which on Lake Superior attain a thickness of several thousand feet, and passing downwards we find a succession of limestones, marls and argillaceous sandstones, interstratified with greenstone and amygdaloid, and followed by about 2000 feet of bluish slates and sandstones, with cherty beds containing grains of anthracite, the whole underlaid by conglomerates, and reposing unconformably upon rocks of the Huronian system. The presence of such slates is the more significant from the occurrence already mentioned of fragments of green and black slates in the coarse grained sandstones near the base of the Potsdam, at Hemmingford mountain, showing the existence of argillaceous shales before the deposition of the quartzites of the Potsdam; these are more recent than the lowest shales of the

* Murchison, Quar. Jour. Geol. Society, vol. xv, 353 and xvi, 215.

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Primordial zone, to which, however, palæontologically they appear to belong.

This Quebec group is of considerable economic interest inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, zinc, copper, silver, cobalt, nickel, chrome and titanium. I have long since called attention to the constant association of the latter metals, particularly chrome and nickel, with the ophiolites and magnesian rocks of this series, while they are wanting in similar rocks of Laurentian age. (This Journal, [2], xxvi, 237).

The immense deposits of copper ores in Eastern Tennessee, and the similar ones in Lower Canada, both of which are for the most part in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to have been preëminently the metalliferous period.

The metals of the Quebec group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or as at Acton, are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be in a few words the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust. The present occurrence of these metals in waters which are alkaline from the presence of carbonate of soda, is as we have elsewhere pointed out, of great significance when taken in connection with the metalliferous character of certain dolomites, which as we have shown probably owe their origin to the action of similar alkaline springs upon basins of sea water.

The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline car-

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bonates, chlorids and sulphurets at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits.*

The sediments of the carboniferous period, like those of earlier formations, exhibit towards the east a great amount of coarse sediments, evidently derived from a wasting continent, and are nearly destitute of calcareous beds. In Nova Scotia Sir William Logan found by careful measurement, 14,000 feet of carboniferous strata; and Professor Rogers gives their thickness in Pennsylvania as 8000 feet, including at the base 1400 feet of conglomerate, which disappears before reaching the Mississippi. In Missouri Prof. Swallow finds but 640 feet of carboniferous strata, and in Iowa their thickness is still less, the sediments composing them being at the same time of finer materials. In fact, as Mr. Hall remarks, throughout the whole palæozoic period we observe a greater accumulation and a coarser character of sediments along the line of the Appalachian chain, with a gradual thinning westward, and a deposition of finer and farther transported matter in that direction. To the west, as this shore-derived material diminishes in volume, the amount of calcareous matter rapidly augments. Mr. Hall concludes therefore that the coal-measure sediments were driven westward into an ocean, where there already existed a marine fauna. At length, the marine limestones predominating, the coal measures come to be of little importance, and we have a great limestone formation of marine origin, which in the Rocky Mountains and New Mexico occupies the horizon of the coal, and itself unaltered, rests on crystalline strata like those of the Appalachian range. In truth, Mr. Hall observes, the carboniferous limestone is one of the most extensive marine formations of the continent, and is characterized over a much greater area by its marine fauna than by its terrestrial vegetation.

"The accumulations of the coal period were the last that gave form and contour to the eastern side of our continent, from the Gulf of St. Lawrence to the Gulf of Mexico; and as we have shown that the great sedimentary deposits of successive periods have followed essentially the same course, parallel to the mountain ranges, we naturally inquire: What influence this accumulation has had upon the topography of our country, and whether the present line of mountain elevation from northeast and southwest is in any way connected with the original accumulation of sediments?" *Hall's Introduction*, p. 66.

The total thickness of the palæozoic strata along the Appalachian chain is about 40,000 feet, while the same formations in

* Quar. Jour. Geol. Soc., vol. xv, 580.

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the Mississippi valley, including the carboniferous limestone, which is wanting in the east, have, according to Mr. Hall, a thickness of scarce 4000 feet.* In many places in this valley we find the Silurian formations exposed, exhibiting hills of 1000 feet, made of horizontal strata, with the Potsdam sandstone for their base, and capped by the Niagara limestone, while the same strata in the Appalachians would give them ten to sixteen times that thickness. Still, as Mr. Hall remarks, we have there no mountains of corresponding altitude, that is to say, none whose height, like those of the Mississippi valley, equals the actual vertical thickness of the strata comprising them. In the west there has been little or no disturbance, and the highest elevations mark essentially the aggregate thickness of the strata comprising them. In the disturbed regions of the east on the contrary, though we can prove that certain formations of known thickness are included in the mountains, the height of these is never equal to the aggregate amount of the formations. "We thus find that in a country not mountainous, the elevations correspond to the thickness of the strata, while in a mountainous country, where the strata are immensely thicker, the mountain heights bear no comparative proportion to the thickness of the strata." "While the horizontal strata give their whole elevation to the highest parts of the plain, we find the same beds folded and contorted in the mountain region, and giving to the mountain elevations not one-sixth of their actual measurement."

Both in the east and west, the valleys exhibit the lower strata of the palæozoic series, and it is evident that had the eastern region been elevated without folding of the strata, so as to make the base of the series correspond nearly with the sea level, as in the Mississippi valley, the mountains exposed between these valleys, and including the whole palæozoic series, would have a height of 40,000 feet; so that the mountains evidently correspond to depressions of the surface, which have carried down the bottom rocks below the level at which we meet them in the valleys. In other words the synclinal structure of these mountains depends upon an actual subsidence of the strata along certain lines.

We have been taught to believe that mountains are produced by upheaval, folding and plication of the strata, and that from some unexplained cause these lines of elevation extend along

* In Michigan according to the late report of Prof. Winchell the total observed thickness of the strata from the top of the Sault St. Mary sandstones to the top of the carboniferous series is little over 1790 feet, divided as follows:—Trenton and Hudson River groups, 50 feet, Upper Silurian 185, Devonian 782, Carboniferous 700; of this last the true coal measures constitute 123 feet, including from 3 to 10 feet of workable bituminous and cannel coals, while near the base of the carboniferous series are found 169 feet of gypsiferous marls, which yield strong brine springs.

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certain directions, gradually dying out on either side, and subsiding at the extremities. We have, however, here shown that the line of the Appalachian chain is the line of the greatest accumulation of sediments, and this great mountain barrier is due to original deposition of materials, and not to any subsequent forces breaking up or disturbing the strata of which it is composed."

We have given Mr. Hall's reasoning on this subject, for the most part in his own words, and with some detail, for we conceive that the views which he is here urging are of the highest importance to a correct understanding of the theory of mountains. In the last volume of this Journal ([2], xxx, 137,) will be found an allusion to the rival theories of upheaval and accumulation as applied to volcanic mountains, the discussion between which we conceive to be settled in favor of the latter theory by the reasonings and observations of Constant-Prevost, Scrope and Lyell. A similar view applied to mountain chains like those of the Alps, Pyrennees and Alleghanies, which are made up of aqueous sediments, has been imposed upon the world by the authority of Humboldt, Von Buch and Elie de Beaumont, with scarcely a protest. Buffon, it is true, when he explained the formations of continents by the slow accumulation of detritus beneath the ocean, conceived that the irregular action of the water would give rise to great banks or ridges of sediments, which when raised above the waves must assume the form of mountains, and later, in 1832, we find De Montlosier protesting against the elevation hypothesis of Von Buch, and maintaining that the great mountain chains of Europe are but the remnants of continental elevations which have been cut away by denudation, and that the foldings and inversions to be met with in the structure of mountains are to be looked upon only as local and accidental.

In 1856, Mr. J. P. Lesley published a little volume entitled *Coal and its Topography*, (12mo, pp. 224), in the second part of which he has in a few brilliant and profound chapters discussed the principles of topographical science with the pen of a master. Here he tells us that the mountain lies at the base of all topographical geology. Continents are but congeries of mountains, or rather the latter are but fragments of continents, separated by valleys which represent the absence or removal of mountain land (p. 126); and again "mountains terminate where the rocks thin out." (p. 144.)

The arrangement of the sedimentary strata of which mountains are composed may be either horizontal, synclinal, anticlinal or vertical, but from the greater action of diluvial forces upon anticlinals in disturbed strata it results that great mountain

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chains are generally synclinal in their structure, being in fact but fragments of the upper portion of the earth's crust, lying in synclinals, and thus preserved from the destruction and translation which has exposed the lower strata in the anticlinal valleys, leaving the intermediate mountains capped with lower strata. The effects of those great and mysterious denuding forces which have so powerfully modified the surface of the globe become less apparent as we approach the equatorial regions, and accordingly we find that in the southern portion of the Appalachian chain many of the anticlinal folds have escaped erosion, and appear as hills of an anticlinal structure. The same thing is occasionally met with further north; thus Sutton mountain in Canada, lying between two anticlinal valleys, has an anticlinal centre, with two synclinals on its opposite slopes. Its form appears to result from three anticlinals, the middle of which has to a great extent escaped denudation.

The error of the prevailing ideas upon the nature of mountain chains may be traced to the notion that the disturbed condition of the strata was not only essential to the structure of a mountain, but an evidence of its having been formed by local upheaval, and the great merit of De Montlosier and Lesley, (the latter altogether independently,) is to have seen that the upheaval has been in all cases not local but continental, and that the disturbance so often seen in the strata is neither dependent upon elevation nor essential to the formation of a mountain. The synclinal structure of portions of the Alps, previously observed by Studer and others, has been beautifully illustrated by Ruskin in the fourth volume of his *Modern Painters*, and in a late review of Alpine geology we have endeavored to show that the Alps, *as a whole*, have likewise a synclinal structure. (Amer. Jour. Science, xxix, 118.)

Such was the state of the question when Mr. Hall came forward, bringing his great knowledge of the sedimentary formations of North America to bear upon the theory of continents and mountains. These were first advanced in his address delivered before the American Association for the Advancement of Science, as its president, at Montreal in August, 1857. This address was never published, but the author's views were brought forward in the first volume of his *Report on the Geology of Iowa*, p. 41, and with more detail in the introduction to the third volume of his *Palæontology of New York*, from which we have taken the abstract already given. He has shown that the difference between the geographical features of the eastern and central parts of North America is directly connected with the greater accumulation of sediment along the Appalachians. He has further shown that so far from local elevation being concerned in the formation of these mountains, the strata which

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form their base are to be found beneath their foundations at a much lower horizon than in the undisturbed hills of the Mississippi valley, and that to this depression, chiefly, is due the fact that the mountains of the Appalachian range do not, like those hills, exhibit in their vertical height above the sea the whole accumulated thickness of the palæozoic strata which lie buried beneath their summits.

Mr. Hall has made a beautiful application of these views to explain the fact of the height of the Green mountains over the Laurentides, and of the White mountains over the former, by remarking that we have successively the Lower and Upper Silurian strata superimposed on those of the Laurentian system. The same thing is strikingly shown in the fact that the higher mountain chains of the globe are composed of newer formations, and that the summits of the Alps are probably altered sediments of tertiary age. (This Journal, xxix, 118.)

The lines of mountain elevation of De Beaumont are according to Hall, simply those of original accumulations, which took place along current or shore lines, and have subsequently, by continental elevations, produced mountain chains. They were not then due to a later action upon the earth's crust, "but the course of the chain and the source of the materials were predetermined by forces in operation long anterior to the existence of the mountains or of the continent of which they form a part." p. 86.

It will be seen from what we have said of Buffon, De Montlosier and Lesley that many of the views of Mr. Hall are not new but old; it was, however, reserved to him to complete the theory and give to the world a rational system of orographic geology. He modestly says, "I believe I have controverted no established fact or principle beyond that of denying an influence of local elevating forces, and the intrusion of ancient or plutonic formations beneath the lines of mountains, as ordinarily understood and advocated. In this I believe I am only going back to the views which were long since entertained by geologists relative to continental elevations." p. 82.

The nature of the palæozoic sediments of North America clearly show that they were accumulated during a slow progressive subsidence of the ocean's bed, lasting through the palæozoic period, and this subsidence which would be greatest along the line of greatest accumulation, was doubtless, as Mr. Hall considers, connected with the transfer of sediment and the variations of local pressure acting upon the yielding crust of the earth, agreeably to the view of Sir John Herschel. The subsidence of the ocean's bottom would, according to Mr. Hall, cause plications in the soft and yielding strata. Lyell had already in speculating upon the results of a cooling and contracting sea of

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molten matter, such as he imagined might have once underlaid the Appalachians, suggested that the incumbent flexible strata, collapsing in obedience to gravity would be forced, if this contraction took place along narrow and parallel zones of country, to fold into a smaller space as they conformed to the circumference of a smaller arc, "thus enabling the force of gravity, though originally exerted vertically, to bend and squeeze the rocks as if they had been subjected to lateral pressure.*

Admitting thus Herschel's theory of subsidence and Lyell's of plication, Mr. Hall proceeds to inquire into the great system of foldings presented by the Appalachians. The sinking along the line of greatest accumulation produces a vast synclinal, which is that of the mountain ranges, and the result of such a sinking of flexible beds will be the production within the greater synclinal of numerous smaller synclinal and anticlinal axes, which must gradually decline toward the margin of the great synclinal axis. This process the author observes appears to furnish a satisfactory explanation of the difference of slope on the two sides of the Appalachian anticlinals, where the dips on one side are uniformly steeper than on the other. p. 71.

An important question here arises, which is this;—while admitting with Lyell and Hall that parallel foldings may be the result of the subsidence which accompanied the deposition of the Appalachian sediments, we inquire whether the cause is adequate to produce these vast and repeated flexures, presented by the Alleghanies. Mr. Billings in a recent paper in the *Canadian Naturalist* (Jan. 1860), has endeavored to show that the foldings thus produced must be insignificant when compared with the great undulations of strata, whose origin Prof. Rogers has endeavored to explain by his theory of earthquake waves propagated through the igneous fluid mass of the globe, and rolling up the flexible crust. We shall not stop to discuss this theory, but call attention to another agency hitherto overlooked, which must also cause contraction and folding of the strata, and to which we have already alluded (Am. Jour. Sci. [2], xxx, 138). It is the condensation which must take place when porous sediments are converted into crystalline rocks like gneiss and mica-slate, and still more when the elements of these sediments are changed into minerals of high specific gravity, such as pyroxene, garnet, epidote, staurotide, chaistolite and chloritoid. This contraction can only take place when the sediments have become deeply buried and are undergoing metamorphism, and is, as many attendant phenomena indicate, connected with a softened and yielding condition of the lower strata.

We have now in this connection to consider the hypothesis which ascribes the corrugation of portions of the earth's crust to

* Travels in N. America, 1st visit, vol. i, p. 78.

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the gradual contraction of the interior. An able discussion of this view will be found in the American Journal of Science [2] iii, 176, from the pen of Mr. J. D. Dana, who, in common with all others who have hitherto written on the subject, adopts the notion of the igneous fluidity of the earth's interior.

We have however elsewhere given our reasons for accepting the conclusion of Hopkins and Hennessy that the earth, instead of being a liquid mass covered with a thin crust, is essentially solid to a great depth, if not indeed to the centre, so that the volcanic and igneous phenomena generally ascribed to a fluid nucleus have their seat as Keferstein and after him Sir John Herschel long since suggested, not in the anhydrous solid unstratified nucleus, but in the deeply buried layers of aqueous sediments which, permeated with water, and raised to a high temperature, become reduced to a state of more or less complete igneo-aqueous fusion. So that beneath the outer crust of sediments, and surrounding the solid nucleus we may suppose a zone of plastic sedimentary material, adequate to explain all the phenomena hitherto ascribed to a fluid nucleus. (Quar. Jour. Geol. Society, Nov. 1859. Canadian Naturalist, Dec. 1859, and Amer. Jour. Sci. [2,] xxx, 136).

This hypothesis, as we have endeavored to show, is not only completely conformable with what we know of the behavior of aqueous sediments impregnated with water and exposed to a high temperature, but offers a ready explanation of all of the phenomena of volcanos and igneous rocks, while avoiding the many difficulties which beset the hypothesis of a nucleus in a state of igneous fluidity. At the same time any changes in volume resulting from the contraction of the nucleus would affect the outer crust through the medium of the more or less plastic zone of sediments, precisely as if the whole interior of the globe were in a liquid state.

The accumulation of a great thickness of sediment along a given line would by destroying the equilibrium of pressure cause the somewhat flexible crust to subside; the lower strata becoming altered by the ascending heat of the nucleus would crystallize and contract, and plications would thus be determined parallel to the line of deposition. These foldings, not less than the softening of the bottom strata, establish lines of weakness or of least resistance in the earth's crust, and thus determine the contraction which results from the cooling of the globe to exhibit itself in those regions and along those lines where the ocean's bed is subsiding beneath the accumulating sediments. Hence we conceive that the subsidence invoked by Mr. Hall, although not the sole nor even the principle cause of the corrugations of the strata, is the one which determines their position and direction, by making the effects produced by the contraction, not only

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of sediments, but of the earth's nucleus itself, to be exerted along the lines of greatest accumulation.

It will readily be seen that the lateral pressure which is brought to bear upon the strata of an elongated basin by the contraction of the globe, would cause the folds on either side to incline to the margin of the basin, and hence we find along the Appalachians, which occupy the western side of such a great synclinal, the steeper slopes, the overturn dips or folded flexures, and the overlaps from dislocation are to the westward, so that the general dip of the strata is to the centre of the basin, on the other side of which we might expect to find the reverse order of dips prevailing. The apparent exceptions to this order of upthrows to the southeast in the Appalachians appear to be due to small downthrows to the southeast, parallel to and immediately to the northwest of great upheavals in the same direction.

Mr. Hall adopts the theory of metamorphism which we have expounded in the pages of this Journal and in the paper just quoted above, (see also Am. Jour. Sci. [2,] xxv, 287, 435, xxx, 135), which has received a strong confirmation from the late researches of Daubrée. According to this view, which is essentially that put forward by Herschel and Babbage, these changes have been effected in deeply buried sediments by chemical reactions, which we have endeavored to explain, so that metamorphism, like folding, takes place along the lines of great accumulation. The appearance at the surface of the altered strata is the evidence of a considerable denudation. It is probable that the gneissic rocks of Lower Silurian age in North America were at the time of their crystallization overlaid by the whole of the palæozoic strata, while the metamorphism of carboniferous strata in eastern New England points to the former existence of great deposits of newer and overlying deposits, which were subsequently swept away.

On the subject of igneous rocks and volcanic phenomena, Mr. Hall insists upon the principles which we were, so far as we know, the first to point out, namely their connection with great accumulations of sediment, and of active volcanos with the newer deposits. We have elsewhere said: "the volcanic phenomena of the present day appear, so far as we are aware, to be confined to regions of newer secondary and tertiary deposits, which we may suppose the central heat to be still penetrating, (as shown by Mr. Babbage), a process which has long since ceased in the palæozoic regions." To the accumulation of sediments then we referred both modern volcanos and ancient plutonic rocks; these latter, like lavas, we regard in all cases as but altered and displaced sediments, for which reason we have called them exotic rocks. (Am. Jour. Sci. [2,] xxx, 133). Mr. Hall reiterates these

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views, and calls attention moreover to the fact that the greatest outbursts of igneous rock in the various formations appear to be in all cases connected with rapid accumulation over limited areas, causing perhaps disruptions of the crust, through which the semi-fluid stratum may have risen to the surface. He cites in this connection the traps with the palæozoic sandstones of Lake Superior, and with the mesozoic sandstones of Nova Scotia and the Connecticut and Hudson valleys.

It may sometimes happen that the displaced and liquified substratum will find vent, not along the line of greatest accumulation, but along the outskirts of the basin. Thus in eastern Canada it is not along the chain of the Notre Dame mountains, but on the northwest side of it that we meet with the great outbursts of trachyte and dolerite, whose composition and distribution we have elsewhere described. (Report of Geological Survey for 1858, and Am. Jour. Science, [2,] xxix, 285).

The North American continent, from the grand simplicity of its geological structure, and from the absence, over great areas, of the more recent formations, offers peculiar facilities for the solution of some of the great problems of geology; and we cannot finish this article without congratulating ourselves upon the great progress in this direction which has been made within the last few years by the labors of American geologists.

Montreal, March 1st, 1861.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.

1. *On Regelation.*—In the year 1850, Prof. Faraday directed the attention of scientists to the remarkable fact that two pieces of moist ice when placed in contact will unite, even when the surrounding temperature is above 0° C. To the phenomenon in question the term "regelation," has been applied by Tyndall, who has made the fact above mentioned the basis of a theory of the plasticity of ice, in accounting for the descent of glaciers. Several theories have been advanced to explain the facts of regelation. Faraday* explained it by assuming that a particle of water can retain its fluid condition only when in contact with ice on one side, but freezes when touched by ice on both sides, the general temperature remaining the same. This explanation—with all deference be it said—is simply a re-statement of the fact and not an assignment of a physical cause. Person maintains that the solution of ice is a *gradual* process, the ice passing through intermediate states of viscosity to the condition of a liquid. He considers ice as essentially colder than the water in contact with it; that a film of plastic ice or viscid water lies between the ice and the water, and that heat is constantly passing from the water to

* Researches in Chemistry and Physics, pp. 373, 378.

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the ice through this film. The water therefore becomes colder and finally freezes. This view is adopted by Prof. J. D. Forbes.* Neither Person nor Forbes explain why a thin film of water in contact with a mass of ice has or can have any other temperature than the ice itself, nor why water at 0° should give off heat to ice at 0°. Prof. James Thomson's theory† is in his own words as follows: If to a mass of ice at its melting point, pressures tending to change its form be applied, there will be a continual succession of pressures applied to particular parts—liquefaction occurring in these parts through the lowering of the melting-points by pressure—evolution of the cold (*sic*) by which the so melted portions had been held in the frozen state—dispersion of the water so produced in such directions as will afford relief to the pressure—and recongelation by the cold previously evolved, of the water on its being relieved from this pressure: the cycle of operations will then begin again; for the parts re-congealed, after having been melted, must in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied and to proceed through successive operations as before. This theory certainly appears to be tenable in the case of glaciers, or wherever great pressures are applied, as in the moulding of ice under a hydrostatic press, but its application is to say the least, doubtful in the case of simple contact between small masses of ice. Moreover Faraday has shown that pressure is not necessary in regelation. Of the numerous experiments which he has instituted the following appears to us the most convincing. Two round cakes of ice, convex upon the upper surfaces, are placed in water of ordinary temperature and then sunk beneath the surface by little weights of wax or spermaceti. Two such pieces of ice touching each other gently at a single point freeze together. In this case no sensible capillary action takes place in consequence of the figures of the masses of ice. Faraday did not succeed in obtaining regelation with melted bismuth, tin and lead, nor with glacial acetic acid, or saline bodies. He considers the phenomenon therefore as peculiar to water. W. G.

2. *On the changes produced in the position of the fixed lines in the spectrum of hyponitric acid by changes in density.*—Weiss has found by actual measurement that the distance between the dark lines in the spectrum of hyponitric acid diminishes as the density of the gas increases. The measurements were made with an Oertling's circle reading directly to two seconds of arc and, by a filar micrometer in the ocular, to a single second. The same phenomenon occurs with the spectrum of chlorophyll. The stronger the extract in ether the less is the distance of the absorption bands. Thus the absorption-band in the red in the case of a strong extract corresponds quite well with Fraunhofer's line C; in the case of a weak extract it stands at some distance from it. The other absorption-bands in this spectrum undergo similar dislocations.

These changes in the distances of the dark lines are very sensible even in the spectrum of hyponitric acid, when the changes in the density of the gas are considerable; they are not however equal for all the dark lines.

* Proceedings of the Royal Society of Edinburgh, April 19th, 1858.

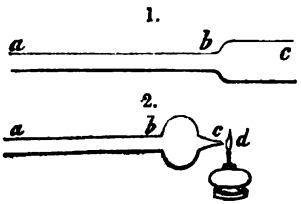
† Royal Society Proceedings, vol. x, p. 152.

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The cause of these dislocations is to be sought, according to Weiss, in a one-sided absorption which each line undergoes toward the violet end of the spectrum, when the density of the body is increased. This is shown by direct observations and comparisons with the solar spectrum as well as by numerous measurements. There is no specific absorption upon both sides of each line, but only an absorption upon the side of the line which lies toward the violet end of the spectrum. In this manner the bands become broader and the distance between them less. The author has observed similar changes in the breadth of Fraunhofer's lines at sunset. In this case also the absorption was only upon one side. From this it appears that the lines of hyponitric acid cannot be used as standards in determinations of indices, &c.—*Pogg. Ann.*, cxii, p. 153, Jan. 1861. W. G.

3. *Note on Dr. J. LeConte's Paper (on the influence of Musical Sounds on the flame of a jet of Coal Gas,* [This Jour. [2], xxv, 62]), *with an experiment by Dr. Charles Sondhauss,* Director of the Realschule of Neisse, (in a letter to Dr. William Sharswood).—"The observation of your friend Dr. LeConte is very interesting, although I must beg leave to differ from his theory of "molecular cohesion," or attraction between the particles of an aeriform body, particularly at the high temperature of flame. Such an hypothesis, however, seems to me unnecessary as an explanation of the phenomenon; nor does this theory demonstrate that the gas-flame is a body different from air:—in which case the flame would be removed from the external tendency to oscillation, and by its own oscillation would even bring the surrounding air or gas column into a state of fluctuation and singing, as in the case of the chemical harmonicon.

Thus a flame operates to surround and hold together the gas column as a separate body. This becomes quite evident from the following experiment which I have devised.



I employ a glass tube of the following form, fig. 1, or fig. 2, which is open at both ends. Half of the opening (*c*), is placed close to a small flame of an alcohol lamp, (*d*): with the mouth fixed at (*a*), I blow a slow current of air, when there is produced a loud whistling tone, the pitch of which is governed by the dimensions of the apparatus, as well as by the force with which the current of air is produced. The dimensions of the glass tube used by me, are, 150–240 centimetres long, the opening at (*c*), 2–5 millimetres wide, and the diameter of the cylinder or spherical enlargement (*b*, *c*), amounts to 1·5–2·2 ctm.

If we blow a current of air through such a glass tube, without employing the flame as above, there will be produced only a roaring sound, in which there is perceived a tendency to the production of such a tone."

Note by Dr. Sharswood.—To those physicists, who may be inclined to take up the investigation of singing flames, etc., I would suggest, that, the phenomena may be most conveniently produced, by sounding two imperfect intervals in unison, on the flageolet. By two imperfect intervals in unison, I mean two-thirds in unison, one tuned a little flat of the other.

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I subjoin a list of the contributions to Acoustics by Dr. Sondhauss. They have been mostly published as Programmes, and are therefore not generally accessible in this country.*

4. *Color of Blood Globules.—Editorial Note to Dr. Reuben's paper*, p. 328.—With regard to the color of single blood globules, it must be admitted that when individual blood globules are viewed under a magnifying power of from 600 to 800 diam., they certainly appear colored distinctly *yellow*, and not red. If now one or two plates of cobalt glass be placed under the stage, or over the eye-piece, the blood globules by virtue of their yellow tint, actually do cut off much of this blue light, probably not less than 50 or 60 per cent. They then appear much darker than the general field; their tint at first sight seems simply dark grey, attentive examination shows it to be dark bluish-green.

Compare also Herschel on the change of tint by an increase of thickness. Herschel on Light, Sect. 495.

In the 8th No. of the *Allgemeine Encyklopœdie der Physik*, (Dec. 1860), Helmholtz details some observations of Purkinje on this subject, which agree with those of Prof. Wm. B. Rogers already published in this Journal. Helmholtz seems in doubt whether to attribute this appearance (seen with the naked eye,) to the flow of blood globules or to some other cause. He adds, "If this appearance has actually a connection with the circulation of the blood, we can admit at the most only, that single lymph corpuscles rich in fat and passing through some of the larger vessels, become visible in this manner."

5. *Subjective Optical Phenomena.*—In the London and Edinburgh Phil. Magazine, Jan. 1861, Sir David Brewster gives a short account of some optical experiments of a subjective nature. A blackened card provided with slits was moved rapidly before a circular aperture in the window shutter of a dark room; the aperture appeared then colored; reckoning from the centre, white or bluish, darker blue, white, dark ring, white, greenish yellow, reddish. It is unfortunate that neither he nor other observers have detailed the rates of motion they communicated to the slits, so as to render a comparison of observations possible. I infer from a slight repetition of these experiments that the rates were much lower than those employed by me. See No. 90 of this Journal, 1860.

He found also when the luminous impressions succeeded each other at a certain (long or short?) interval, that a hexagonal pattern was plainly visible. Compare a similar observation of *Purkinje*† under the same circumstances. Streams of moving particles have also been observed, and have been ascribed by Vierordt, to the blood circulation in the retina, becoming momentarily visible.† I have often caught distinct glimpses of this appearance. O. N. R.

* (I.) Ueber die Schallschwingungen der Luft in erhitzten Glasröhern und in gedeckten Pfeifen von ungleicher Weite.—Ann. ch. u. Ph. lxxii, pp. 1-34.

(II.) Ueber den Brummkreisel und das Schwingungsgesetz der trobischen Pfeifen, —Jahresbericht K. Kath. Gymnasiums Breslau, 1850, pp. 3-37.

(III.) Ueber die beim Ausströmen der Luft entstehenden Töne.—Programme der Realschule zu Neisse, 1858, pp. 1-31, reprinted in Ann. ch. u. Ph. xci, p. 129, et infra.

(IV.) Ueber die Chemische Harmonika.—Programm der Realschule zu Neisse, 1859, pp. 1-43. (A very learned and full resume, together with valuable contributions to the subject).

† *Physiologische Optik*, by H. Helmholtz, 1860, page 381.

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6. *On some illusions, and other phenomena, attendant on vision through colored media;* by SIMON NEWCOMB.—(1.) Let one put a red glass over the right eye, pressing it in so closely that little or no light can get to the eye except through the glass, hold a green or blue one over the left eye in the same manner, and thus look at surrounding objects in general for a few minutes. On removing the glass he will find that white objects will appear greenish when observed with the right eye alone, and reddish, or tinged with orange, when viewed with the left eye alone.

Evidently this illusion must be one of *sensation*, and not one merely of *judgment;* the term illusion (or error) of sensation, being applied to the case in which the impression actually conveyed to the mind is different from that ordinarily conveyed by the same exciting cause; and the term illusion or error of judgment to the case in which the mind forms an erroneous opinion respecting the nature of the impession. We are frequently, though not always, able to refer an observed illusion to one or the other of these two classes. Thus, in the case of the apparent enlargement of the celestial bodies when near the horizon, it is well known that the illusion is not in the impression of magnitude actually conveyed by the optic nerve to the brain, but that the mind, from a well known cause forms an erroneous judgment respecting the apparent magnitude. The above mentioned illusion resulting from observation through colored media is evidently one of sensation, because, the mind which judges being singular, would form the same sort of erroneous opinion respecting a sensation transmitted by one eye that it would respecting a similar sensation transmitted by the other. The glasses may be held so that it will be impossible for the observer to say which eye is covered by the red glass and which by the green one; yet on removing the glasses he can speedily solve the question by shutting the eyes alternately.

This phenomenon may be accounted for on the general principle that the increase of sensibility of the eye when placed for some time in darkness takes place independently with respect to the several colors of light; so that an eye from which all the red light is excluded will become sensitive to red light with equal rapidity whether light of other colors is admitted or excluded.

[This is analogous to the experiment of Count Schoffgotsch. His diploscope consists of a rotating disc painted half green, half red, and is observed through two tubes held before the two eyes. One eye becomes fatigued by the green light, the other by the red; if now the disc is set in rotation, the first eye sees only red, the other only green light. (See Eisenlohr, *Physik*, p. 327.)]

2. The two following experiments illustrate very finely the doctrine of corresponding retina points, and the inability of the eye to distinguish the organ by which observed sensation is conveyed.

With the glasses arranged as already mentioned look at a piece of white paper, having on it two spots, one of a very bright red, and the other of a very bright and pure green or greenish blue. If the left eye be closed the green spot will appear entirely black, while the red spot will appear so nearly of the general color of the paper as to be scarcely visible, and will not present the faintest indication of being red. If the right eye be closed the red spot will seem black, and the green spot will appear of

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the color of the paper; but if both eyes be open, the spots will both appear of their natural color.

Under the same circumstances look at a white spot of paper with a single black spot on it. The spot will of course appear black, while the paper will be of those uncertain, mixed and ever varying shades which we know to be the result of looking at white objects in this manner. But, let the paper be now brought so close to the eye that two images of the spot may be seen. Instead of one or both images seeming black, that which corresponds to the black image as seen through the red glass will be of a bright green, while the other will be of a bright red. This is the result we ought to expect. To fix the ideas, and avoid troublesome phrases, let I represent the portion of the right retina on which the image of the spot falls, and I′ the corresponding portion of the left retina. Let J′ represent the portion of the retina of the left eye on which the image falls, and J the corresponding portion of the right retina. Call E and E′ all those portions of the respective retinas except L+I, and J+J′. Then the mind can make no distinction between the impression conveyed by L, and that conveyed by L′, and so of the other portions. From the arrangement of the glasses we have

On E red light, on E′ green light; result, an uncertain white.
On I darkness, on I′ green light; result, green.
On J red light, on J′ darkness; result, red.

These results correspond with the observed phenomena. It will be observed that the greenness of the apparent image of the spot seen by the right eye proceeds from the green light which falls on the corresponding point of the left eye, where it is not neutralized by the red light of the right eye. The result of the previous experiment is to be explained in a similar manner. [Compare Dove's experiment of looking at a green pattern on a red ground through red and green glasses. This vol., p. 109].

3. Suppose now that the green glass is removed, the eyes still observing a double image. It might then be supposed that the red image would preserve its color, since the nature of the light falling on the portions J, J′, of the retinas is not changed; and that the other image would lose all coloration, since it is now produced by white light on the one retina and darkness on the other. But the real result will be singularly the converse of this. The first image will lose nearly every trace of red, appearing almost perfectly black, while the second one will preserve its apparent greenness in all its brilliancy, though not a particle of green light (except what helps to form white,) can reach either eye! Vice versa, if the red glass be removed, the green image will change to black, while the red one will preserve its apparent color.

[No. 3 may be explained by the well known fact that when we look at an object placed so near the eyes that a double image is seen, the right image belongs to the left eye, and vice versa; also that a black object on a red field soon assumes a green tint, and *v. v.*]

CHEMISTRY.—

7. *Researches on the mutual relations of the Equivalents.*—With this title J. S. STAS has communicated the results of a ten years' laborious investigation, devoted specially to the examination of Prout's often dis-

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cussed hypothesis. The memoir in question is one of extraordinary thoroughness and detail, which requires to be carefully studied, and does not admit of an abstract. Full details are given of the balances employed, of the methods of purification and analysis made use of; of the vessels used and the changes which they undergo; in short of all the precautions required to render the results as free as possible from errors of observation.

The result of this immense and conscientious labor is that *there is no common divisor* for the equivalents of the elements. In his own words, the author has attained "the full conviction, and so far as is humanly possible the perfect certainty, that Prout's law, together with the modifications introduced by Dumas, is nothing but a deception, a pure hypothesis."

The equivalents deduced by Stas are as follows:

Potassium,	39·154	from the decomposition of the chlorate.
Sodium,	23·05	
Ammonium,	18·06	
Silver,	107·94	
Lead,	103·45	from the synthesis of the sulphate.
"	103·46	" " " " nitrate.
Chlorine,	35·46	
Nitrogen,	14·04	
Sulphur,	16·03	

Berzelius found for potassium 39·150; Pelouze 39·156, and Marignac 39·161. By comparing the equivalents of ammonium and nitrogen in the table it will be seen that the difference is 4·02 instead of 4·00. As the equivalent of nitrogen was deduced from the synthesis of nitrate of silver, it follows either that this is inaccurate, or that the equivalent of hydrogen is inaccurate by the $\frac{1}{100}$ of its value. Stas considers the last as probable, and proposes to institute a new investigation of the composition of water.—*Recherches sur les rapports réciproques des poids atomiques, Brux.* 1860, quoted in *Jour. für prakt. Chemie*, 29, p. 65, No. 2, 1861.

W. G.

8. *On the polyatomic bases of the nitrogen, phosphorus and arsenic series.*—A. W. Hofmann has given some general views on the structure of the ammonia-derivatives which will serve as a useful guide in the study of the immense number and variety of new bases with which he has enriched the science. When dibromid of ethylene $C_4H_4Br_2$ reacts with a monamin, as for example with ammonia, either one or two molecules of the latter are fixed and there result two series of salts, one of which is monatomic and the other diatomic, and the composition of which is expressed in the following formulas:

I. Diatomic series.		II. Monatomic series.	
$[(C_4H_4)'' H_6N_2]''Br_2$ $[(C_4H_4)''_2H_4N_2]''Br_2$ $[(C_4H_4)''_3H_2N_2]''Br_2$ $[(C_4H_4)''_4 N_2]''Br_2$	Ethylene bases.	$[(C_4H_4Br) H_3N]Br$ $[(C_4H_4Br)_2H_3N]Br$ $[(C_4H_4Br)_3H N]Br$ $[(C_4H_4Br)_4 N]Br$	Bromethyl bases.

In the salts of the second series bromine may be eliminated either wholly or partially as bromhydric acid, formed either at the expense of water present—in which case the atomic group HO_2 replaces bromine—

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or at the expense of ethylene itself, in which case vinyl compounds are produced. Two new groups are formed in this manner which may be formulated as follows:

III. Oxethyl bases.	IV. Vinyl bases.
$[(C_4H_4HO_2)\ H_3N]Br$	$[(C_4H_3)\ H_3N]Br$
$[(C_4H_4HO_2)_2H_2N]Br$	$[(C_4H_3)_2H_2N]Br$
$[(C_4H_4HO_2)_3H\ N]Br$	$[(C_4H_3)_3H\ N]Br$
$[(C_4H_4HO_2)_4\ \ N]Br$	$[(C_4H_3)_4\ \ N]Br$

From this it appears that the action of dibromid of ethylene upon ammonia produces sixteen bases, independently of intermediate and secondary products. The reactions are however much simpler with primary, secondary and tertiary monamins, the first class giving twelve, the second eight, and the third four bases. The author obtained the clearest expression of his theoretical views by operating upon triethylamin, triethylphosphin and triethylarsen. When these alkaloids are treated with dibromid of ethylene the following three groups of compounds are formed:

Nitrogen group.	Phosphorus group.	Arsenic group.
$[(C_4H_4)''(C_4H_5)_3N_2]''Br_2$.	$[(C_4H_4)''(C_4H_5)_3P_2]''Br_2$.	$[(C_4H_4)''(C_4H_5)_3As_2]''Br_2$

II. *Bromoethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_4Br)(C_4H_5)_3N]Br$.	$[(C_4H_4Br)(C_4H_5)_3P]Br$.	$[(C_4H_4Br)(C_4H_5)_3As]Br$

III. *Oxethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_5O_2)(C_4H_5)_3N]Br$.	$[(C_4H_5O_2)(C_4H_5)_3P]Br$.	$[(C_4H_5O_2)(C_4H_5)_3As]Br$

IV. *Vinyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_3)(C_4H_5)_3N]Br$.	$[(C_4H_3)(C_4H_5)_3P]Br$.	$[(C_4H_3)(C_4H_5)_3As]Br$

The bodies belonging to the second group, in the presence of other substances, yield very elegant reactions. Treatment with monamines, monophosphines, and monarsines transform them into an inexhaustible group of diammonium, diphosphonium, and diarsonium compounds on the one hand, and of phosammonium, phospharsonium, and arsammonium salts on the other. Polyatomic bases of a higher order result from the action of the diamines—ethylene diamines for instance—upon the bromo-ethylized salts.

The derivation of the oxethyl from the bromo-ethyl salts has already been mentioned. We have, for example, the equation:

$$[(C_4H_4Br)(C_4H_5)_3P]Br + H_2O_2 = BH + [(C_4H_4HO_2)(C_4H_5)_3P]Br.$$

The new salt bears the same relation to the bromo-ethyl salt which alcohol bears to bromid of ethyl. Hence, as might be expected, the oxethyl salt may be converted into the bromo-ethyl salt by distillation with pentabromid of phosphorus.

$$[C_4H_4HO_2)(C_4H_5)_3P]Br + PBr_5 = PO_2Br_3 + HCl + [(C_4H_4Br)(C_4H_5)_3P]Br.$$

The bromo-ethyl bromids may be regarded as tetrethyl compounds in which a molecule of ethyl has been converted into bromo-ethyl. Nascent hydrogen converts the bromo-ethylized bromids into tetrethyl bromids. Thus we have:

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$$[(C_4H_4HBr)(C_4H_5)_3P]Br+2H=HBr+[(C_4H_4)_4P]Br.$$

In conclusion the author points out the possibility of obtaining triatomic, tetratomic and pentatomic bases, either by the action of ammonia upon more highly brominated bromo-ethyl bases or by the same action upon bases containing two, three or four equivalents of bromo-ethyl. Thus we might have the reactions indicated by the equations

$$[(C_4H_3Br_2)H_3N]Br+2H_3N=[(C_4H_3)'''H_9N_3]'''Br_3.$$
$$[(C_4H_2Br_3)H_3N]Br+3H_3N=[(C_4H_2)^{iv}H_{12}N_4]''''Br_4.$$

.

$$[(C_4H_4Br)_2H_2N]Br+2NH_3=[(C_4H_4)_2''H_8N_3]'''Br_3.$$
$$[(C_4H_4Br)_3HN]Br+3NH_3=[(C_4H_4)_3''H_{10}N_4]''''Br_4.$$
$$[(C_4H_4Br)_4N]Br+4NH_3=[(C_4H_4)_4''H_{12}N_5]'''''Br_5.$$

Hofmann has already obtained a series of triatomic bases, of which diethylentriamin may be regarded as especially worthy of notice. The base has the formula

$$C_8H_{13}N_3=\left.\begin{matrix}(C_4H_4)''_2\\H_5\end{matrix}\right\}N_3$$

and is the first triacid ammonia. It forms magnificent salts, the chlorid being

$$[(C_4H_4)''_2H_8N_3]Cl_3.$$

—*Journal für prakt. Chem.*, No. 2, 1861, p. 110, and *Sitzungsberichte der k. Preuss. Acad. zu Berlin*, Oct. 1860. W. G.

9. *On the cyanid of Ethylene.*—Succinic acid bears the same relation to glycol which propionic acid bears to alcohol. As cyanid of ethyl by boiling with hydrate of potash yields ammonia and propionate of potash, it might be expected that under the same circumstances cyanid of ethylene would yield succinate of potash. Simpson has found that this is the case. The cyanid of ethylene, as prepared by the action of bromid of ethylene upon cyanid of potassium, is a semifluid brown and crystalline mass, easily soluble in water and alcohol. When boiled for some time with an alcoholic solution of caustic potash, ammonia is given off and succinate of potash formed. The reaction is expressed by the equation

$$C_4H_4Cy_2+2KHO_2+4HO=C_8H_4K_2O_8+2NH_3.$$

—*Zeitschrift für Chemie und Pharmacie*, Heft. 1, 1861, p. 14. W. G.

10. *On the separation of Mono- Bi- and Triethylamin.*—When iodid of ethyl is heated with ammonia, as Hofmann long since showed, all three ethylated ammonias are formed and these are difficult to separate. Hofmann now finds that the separation is easily affected by adding oxalate of ethyl to the mixed bases. This converts the ethylamin into diethyl-oxamid $\left.\begin{matrix}C_4O_4\\(C_4H_5)_2\\H_2\end{matrix}\right\}N_2$; the diethylamin into diethyl-oxamate of ethyl $\left\{\begin{matrix}C_4H_4\\C_4O_5\\(C_4H_5)_2N\end{matrix}\right\}O_2$, but leaves the triethylamin unchanged. The diethyl-oxamid separates completely as a white crystalline powder while the other two remain fluid and are easily separated by filtration. These two

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may then be separated by distillation, the triethylamin boiling at 91° C. and the ether at 260° C. The two oxamates may then be decomposed by caustic potash and yield the pure alkaloids.—*Zeitschift für Chemie und Pharmacie*, 1861, Heft. 1, 13. W. G.

TECHNICAL CHEMISTRY.

11. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (Concluded from p. 289.)

"One of the most common complaints against yellow-metal arises from a tendency which some specimens of it exhibit to become so friable, after an exposure of longer or shorter duration to sea-water, that the sheets may readily be broken in pieces, sometimes even between the fingers. Attention has recently been called to this subject by Bobierre,* who would refer such cases more particularly to chemical conditions depending, as he thinks, upon the too great proportion of zinc which is used in the preparation of the alloy, yellow-metal, as well as to changes of composition produced by hot rolling.

"I cannot agree with this conclusion. In my own opinion, the other alternative which Bobierre has suggested, namely, peculiar arrangement of the molecules of which the alloy is composed, furnishes the true explanation of the difficulty. It is, however, possible, that at times, when the temperature of the reverberatory, in which the alloy is heated before passing to the rolls, is not properly regulated, zinc may be burned off from the exterior portions of the sheet, and that the alloy richer in copper which would thus be formed may subsequently be pressed into the body of the sheet during the operation of rolling. An alloy destitute of homogeneity would result from this treatment which could hardly be durable in any event. Instances of this sort must nevertheless be rare, for no part of the process is watched by the manufacturers more scrupulously than this.

"It must also be borne in mind, that, of the enormous quantity of yellow-metal which is now used by the merchant vessels of Great Britain and of this country,—all of which is composed of sixty parts of copper and forty parts of zinc, and rolled hot,—only a comparatively small portion passes into the friable condition to which I have alluded.

"In most cases the alteration which the sheathing undergoes is gradual and regular, and the portion which remains after the wear of several years is still malleable. Indeed, the absolute amount of sheathing which becomes friable is entirely out of proportion with the annoyance to which it subjects ship-owners;† for it rarely happens, even in the worst instances, that more than one third of the sheets upon a vessel become friable, the remainder being in good condition.

"The friability is therefore a purely accidental occurrence, and by no means a necessary consequence either of hot rolling or of the presence of 40 per cent of zinc in the alloy, as has been implied by Bobierre.‡ I am strongly of opinion, that it might be in every instance entirely obviated by methodically annealing or tempering the sheets of alloy in such a manner that no fibres could form in them, and that their structure should be homogeneous.

"Bobierre in his very able thesis, to which I have already alluded, has urged that it would be well to discontinue the use of the alloy containing 60 per cent of copper, which admits of being rolled hot, and to substitute for it sheathing prepared from alloys containing about 66 per cent of copper, which can only be prepared by a most laborious process of cold rolling. It is true that the fibres which I have described would in this case probably never be encountered. Still there are several important

* Thèses presentées à la Faculté des Sciences de Paris.
Thèse de Physique: Des Phénomenes électro-chimiques qui caractérisent l'Altération, à la Mer, des Alliages employés pour doubler les Navires. Nantes: Imp. Busseuil. 1858. p. 61.

† Whenever the destruction of a portion of the sheathing requires that a ship be hauled up for repairs, it is customary, since this operation is an expensive one, to resheathe the vessel entirely: for as the friable sheets are interspersed among the others, and since all the sheets are somewhat worn, it would be bad economy to attempt any partial repairs. Of course the owner of the vessel regards the entire suit of sheathing as being worn out, and forms his opinion of the durability of yellow-metal in accordance with this view.

‡ Thèses, p. 77.

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objections to the proposition of M. Bobierre. Not only would the method of cold rolling consume a much greater amount of time and labor; but it would be exceedingly difficult, if not impossible, to procure any alloy the composition of which could be maintained so nearly constant as is the case with yellow-metal.* It is not probable that a test like the one applied to this alloy could be found anywhere else in the whole series

"It is frequently stated in chemical text-books that yellow-metal is always prepared from "best-selected" copper, and one is led to infer that a metal of peculiar purity is alone used in its manufacture. This may once have been the case; but since the immense increase in the use of this alloy, it would no longer be practicable to obtain a sufficient quantity of copper of uniform character, or indeed of any one kind, from which to prepare the large quantity of sheathing which is used. In an establishment where expense would be a secondary consideration, as, for example, in a government workshop, it might still be possible to prepare an alloy constantly from the same sorts of copper and of zinc, in which case, although the amount of zinc lost would probably be subject to considerable variations, one might, nevertheless, soon be able to control the process, and to prepare an alloy of the composition proposed by Bobierre, so that only trifling variations should occur in the composition of the product. But in ordinary practice manufacturers are compelled to make use of the most varied kinds of copper, not only because the supply of the best sorts is limited, but particularly from the fact, that, owing to the competition which exists between the various founderies,—or rather, by force of the laws which regulate supply and demand,—they are obliged to remelt large quantities of old copper sheathing,† the origin of which is unknown to them, and which may have been originally prepared from copper of inferior quality.

"Now since many of the impurities of copper are eliminated when it unites with zinc, being thrown up on the surface of the melted metal as a crust or scum which is removed by the workmen,‡ and as no two samples of copper contain the same kind or quantity of impurity, the amount of it removed, or, what is the same thing, the amount of copper left to unite with a given weight of zinc,§ must continually vary.

"From this it may easily be seen how very difficult, if not impracticable, it would be to obtain anything like constant results, unless some test were found by which the workman might ascertain at least approximately the composition of his alloy.‖

"That it is of the first importance that every alloy used for sheathing shall possess some one constant composition, so that it may endure equally well on all parts of the vessel, and that no voltaic action may occur between the metal of different sheets, is a point too obvious to be mentioned.

"It might still be urged against yellow-metal, that the admixture of other metals —of kinds capable of mingling with it—which may have been derived from the copper used in its preparation, is a serious objection to its use. This is true, and the remark applies with equal or even greater force to all the alloys used for sheathing; it must always depend upon the condition of copper metallurgy. It would apply more forcibly, for example, to the low grade brass which Bobierre has proposed to substitute for the ordinary sheathing metal; for since the "test" by means of which founders are enabled to prepare the alloy—yellow-metal—of constant composition

* An alloy of constant composition might, however, possibly be prepared, by adding known quantities of melted copper to determined volumes of molten yellow-metal which had been prepared by the usual method.

† The popular notion, that a better—"more compact"—product is obtained by *remelting* any alloy, may also have some connection with this custom.

‡ This explains the remark of Karsten (*loc. cit.*, S 386), that perfectly pure copper can take up from 1·5 to 2·5 per cent more zinc than impure, and still afford a product of better color, more tenacious and more malleable

§ Much zinc also is lost in this case, both by alloying with the foreign metal and by uniting with any oxygen which may have been combined with the latter. As the workmen say, impure copper "burns up" a great deal of zinc.

‖ It must be well understood, however, that as a rule manufacturers of alloys of copper and zinc always use the best copper they can obtain, since it is generally more economical for them to do so For the purer this metal is, so much the greater will be the total amount of alloy obtained by the use of a given weight of it, or, in other words, the loss, mentioned in the preceding notes, which would occur from elimination of impurities, will be smaller.

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cannot be obtained if metals are present which are incapable of mixing in all proportions with this alloy, in which event small particles of the foreign substances would be found irregularly disseminated upon the fractured surface of the test ingot, manufacturers are enabled to ascertain at once whether or no a given sample of copper is suitable for the preparation of yellow-metal. Whenever it is found that satisfactory tests cannot be obtained, the copper is immediately rejected by the founders, and applied to some other use. No similar means of controlling the purity of the brass in question are known.

"It does not appear—at all events it has never been proved—that any serious injury results in practice from the use of the most varied kinds of copper, so long as they afford the desired *homogeneous* alloy containing 40 per cent of zinc.

"I do not wish to deny that hurtful impurities may at times occur in yellow-metal, in spite of the test to which I have so frequently alluded. Most probably the very rare cases in which this alloy wears out irregularly, portions of the sheet being much corroded, while other parts are scarcely at all acted upon and have preserved their original color and malleability, may be referred to the irregular diffusion of such impurities throughout the mass of alloy of which the sheet was formed;* but their influence must be regarded as being of very slight importance in comparison with the changes of structure which have already been discussed."

A detailed account of the method of analysis employed [humid assay by means of iron] and a list giving the composition of the different alloys examined, follows. As also, comments upon the violent action which is observed when zinc and copper enter into combination with each other, and upon the remarkable tendency to separate into layers, according to their relative specific gravity, without combining, which these metals exhibit when not mixed together by stirring.

"It is doubtless this tendency of the metals to remain unmixed in separate layers when not subjected to agitation, which has led several chemists to believe that the alloys of copper and zinc are apt to separate by eliquation into two portions respectively rich in copper and zinc; from which they have inferred, as I have previously remarked, the existence of definite compounds."

The color of the alloys is next considered.

"The most contradictory statements have been made by different observers in regard to variations of color among the alloys of copper and zinc. In the specimens which I have myself prepared, no abrupt change or peculiar modification of the true color is to be perceived, although some very striking superficial characters present themselves. Starting from the red of pure copper, the color of the alloys is less red and more yellow in proportion as they contain more zinc, until an alloy containing 75 or 80 per cent of copper is reached, the color of which is almost pure yellow; beyond this point, as the proportion of zinc contained in them is increased, the alloys become less yellow, with perhaps a tinge of green, and more white continually, and this by the most gradual stages, until the well-known white alloys are reached. These remarks refer to the color of polished surfaces as obtained by the use of a fine file."

In several of the alloys however, especially in those containing about equal parts of copper and zinc, a beautiful yellow or sometimes gray irid-

* It is not impossible that the small amount of silver which, as is well known, is precipitated from sea-water upon the metallic sheathing of ships, can accumulate to such an extent in yellow-metal which has been repeatedly used and remelted, that the durability of the latter may be seriously impaired thereby. It is, however, equally probable, and perhaps more so, that the greater part of this silver is eliminated in the preparation of the alloy, when the old metal is fused with zinc.

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escent film forms upon the surface of the metal during the process of cooling. This is probably due to oxydation.

"Marked changes not only of color but also in other of the physical properties of some of these alloys may be produced by varying the conditions in which they pass from the liquid to the solid state. These changes are very peculiar and are evidently of great importance, not only in their practical bearing, but also from affording another instance of the phenomena of 'tempering' which may possibly be of consequence in the study of this most difficult subject."

"In preparing the white alloys containing less than 45 per cent of zinc, I have frequently observed, upon the under surface of the sheet obtained by pouring off the liquid alloy, a thin layer of a soft, tenacious, malleable alloy, of a yellow color. The formation of this singular sheet was at first attributed to eliquation; but as it was difficult to conceive that an alloy apparently richer in copper should remain at the surface of the melted mass in the crucible,—which must have been the case in order that it should form the bottom of the ingot,—it was thought possible that volatilization of the zinc might have increased the proportion of copper at the surface of the melted alloy. In order to decide this question, a new series of alloys was prepared, extending from the one obtained by melting together 40 parts of copper plus 60 parts of zinc, to the mixture of 56 parts of copper and 44 parts of zinc; —each alloy being made from a mixture containing one per cent more copper than that used in preparing the preceding. After thorough stirring, the alloys were cast into ingots of about five pounds' weight. In the first four of these alloys—from 40 to 44 per cent of copper—the yellow film was very clearly defined on the three sides of the ingot which had come in contact with the metal of the mould, while on the upper surface of the ingot, which had cooled in contact with the air, no trace of it could be detected. This yellow film is usually of extreme tenuity, hardly exceeding one-sixteenth of an inch in thickness in any of the instances which I have observed. It is, however, so very clearly defined in the white alloys containing 40 to 45 per cent of copper, being readily bent, cut, or filed, while the remainder of the alloy is exceedingly hard and brittle, that no question as to its identity can possibly be entertained. In the alloys containing more than 50 per cent of copper, which are naturally of a yellow color, it is not so easy to detect a similar film. In the series of ingots just mentioned, it could nevertheless be traced as far up as the alloy prepared from 54 parts of copper plus 46 parts of zinc.

"An experiment made in order to ascertain whether this soft modification of the alloys could be obtained at will, afforded no positive result. An alloy of 42 parts of copper plus 58 parts of zinc being prepared, a portion of it was poured by small drops into a large mass of cold water. The surfaces of many of the granules thus obtained were covered with a yellow film, and this was especially true of the smallest pieces; but the film was exceedingly thin, and the interior of the granules consisted entirely of brittle white alloy. Other portions were thrown out upon cold iron plates, so as to form very thin sheets. A thin yellow film occurred, it is true, upon the inferior surfaces of these sheets, but above it the alloy was white and brittle. Another portion of the melted alloy was cast in an iron ingot-mould which had previously been heated "black-hot." The yellow film was still formed where the alloy came in contact with the ingot-mould; it was, however, exceedingly thin. On pouring some of the remaining alloy into a cold iron mould, a yellow film of the usual thickness was obtained.

"Although the phenomena of tempering exhibited by these alloys are more readily perceived among those the normal color of which is white, it is highly probable that all the alloys are liable to have their physical properties influenced to a greater or less extent from this cause. This would appear, not only from the evident analogy of these phenomena with those which are known to occur with alloys of copper and tin;* but Dussaussoy† has already shown that ordinary brass, copper 65 to 70 per

* *Vid.* d'Arcet in *Dictionnaire de l'Industrie Manufacturière, etc.*, x, 500, Art. *Tam-tam* (Paris, Baillière, 1841); also, *Ann. Ch. et Phys.*, (2.) liv, 331. See also Dussaussoy, *Ann. Ch. et Phys.*, (2.) v, 225. † *Loc. cit.*, p. 226, *et Tableau* No. 5.

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cent plus zinc 30 to 35 per cent, is rendered softer, less tenacious, and less dense by tempering it;—a fact which Mallet* has very properly urged in explanation of the differences between several of the specific gravities of alloys of copper and zinc observed by himself, and the numbers which had been previously obtained by other experimenters. I would here suggest that it explains equally well the very great variations among the specific gravities of the different alloys studied by Mallet himself.† It is also the most probable explanation of the alloys of abnormal color which he has described. I should observe in this connection, that in the alloys of light yellow color the yellow appears to be made much deeper when the alloy is strongly compressed, as when cut with a cold-chisel or hammered. I may also incidentally mention, that in the series of alloys which I have prepared, a constantly increased degree of hardness has been observed, in proportion to the amount of zinc contained in the alloy,—at least as far as the brittle white alloys, which are so hard that an ordinary file makes little or no impression upon them;‡ a result which agrees with those of Karsten§ of Mallet,‖ and of Guettier.¶ Calvert and Johnson** have recently attempted to express these differences numerically. The alloy containing 54 per cent of copper, which is still so tenacious that small bits cannot readily be broken from it, was found to be exceedingly difficult to cut with a cold-chisel; for though still so soft that it could be filed without any very great trouble, it destroyed at once the edges of cutting instruments, though the latter were well tempered. This peculiarity appears to be connected with the fibrous structure of the alloy."

12. *Preparation of Oxygen on the Great Scale.*—In addition to the new methods of obtaining large quantities of oxygen which were reported on page 280, DEVILLE and DEBRAY have now published an elaborate article containing the details of their labors upon this subject to which we would call the attention of technological chemists. In this memoir, which forms a part of their remarkable monograph upon the metallurgy of platinum, &c., they have studied the comparative merits of all the industrial processes of manufacturing oxygen which were known heretofore and of the methods which they have themselves devised,—with a view of enabling any manufacturer to decide which process may be best suited to the locality or circumstances in which he happens to be situated. They describe also a method of preparing oxygen from chlorid of lime which seems to be well adapted for laboratory use,—when heated to low redness, chlorid of lime (bleaching powders) gives off, per pound, from twenty to twenty-five litres of oxygen. This gas is mixed with a little chlorine, from which it may be freed by washing with an alkaline solution, or better, the formation of this impurity may be prevented by adding enough slaked lime to the chlorid employed that this shall be strongly alkaline; if this precaution be attended to, the operation may be conducted in iron vessels. It is of importance only to avoid heating the mass to the fusion

* *Loc. cit.*, p. 264.

† I have found it impossible to construct a curve of any regularity from the observations of this chemist, although it is tolerably clear that the greatest condensation is at a point somewhere below the alloy composed of equal equivalents of copper and zinc, and that between this point and pure copper the specific gravity gradually increases with some degree of regularity in proportion as the amount of copper increases. Among the observed specific gravities of the white alloys rich in zinc, there is no regularity whatsoever. The determinations of Mallet are, nevertheless, unquestionably the best which have ever been made; possibly they are the best which could be made in any case. At all events, few chemists are in the position to improve upon the method of preparing alloys which was employed by this distinguished observer.

‡ From this category the alloys modified by tempering must of course be excepted.

§ *Loc cit.*, S. 393.

‖ *Loc cit.*, p. 307; also Gmelin's Handbook, (Cavendish Soc. Edit.,) v, 479.

¶ *Loc. cit., passim.* ** *Loc. cit.*, p. 199.

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point of the chlorid of calcium. The calcination may even be made in glass vessels. The production of oxygen from this source is very regular and unattended with danger. The process is moreover economical as compared with those commonly employed by chemists;—in the experiments of the authors the cubic metre [35·316 cubic feet] of oxygen when prepared from black oxyd of manganese cost about four francs, from chlorid of lime five francs, while from chlorate of potash it could not be obtained for less than ten francs; but the process is nevertheless far more expensive than their sulphuric acid method, the cubic metre of oxygen having cost in this case not more than one or two francs,—and in practice the price would probably be much less than this, since the sulphurous acid might readily be utilized.

It is worthy of remark that the oxygen prepared from sulphuric acid can be easily obtained in a state of chemical purity.—that made from black oxyd of manganese is always contaminated with nitrogen.—*Ann. de Chim. et Phys.*, [3], lxi, 97, Jan., 1861.

13. *On the "Sweet Fermentation" of Milk.*—On the occasion of a discussion, upon the conditions requisite for the preparation of butter, which took place at the meeting of the convention of Swedish Agriculturalists, in 1858, it occurred to Prof. Alexander Müller of Stockholm, that the simplest explanation of the multifarious appearances which must be noticed and the precautions to be followed in the preparation of good butter, was to be found in the supposition that the original albuminous envelopes of the fat globules in the milk must undergo a solvent fermentation before the butter can be collected. In proof of this view he now offers experimental results, of which the following table is an abstract: As Mitscherlich proved long ago, ether dissolves only mere traces of fat when shaken with milk as it comes from the cow, and dissolves so much the more fat in proportion to the length of time that the milk has been kept.

This milk, which for the sake of convenience had been diluted with an equal volume of water, gave up to ether in the *m*th hour after milking, in the *v*th hour after it had been diluted with water, and after it had been mixed with ether for one hour,* *f* per cent of fat.

No.	*m.*	*v.*	*f.*
1*a.*	2	1	0·55
b.	14	13	1·28
2*a.*	18	1	0·85
b.	38	21	1·52
c.	61	44	2·08
3*a.*	65	1	2·56
b.	86	1	4·52
c.	109	1	4·56

The temperature of the laboratory during these experiments was 15° C. [=59 F.]. No. 3*a*, curdled while being shaken with ether, 3*b*, and 3*c*, were already sour; the other samples were fresh and sweet when treated.

[* By long continued digestion with ether the author shows that much larger amounts of fat than those indicated in the table may be obtained. This has however no immediate bearing upon the point in hand. J. D. D.]

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Although the specimens came from three different milkings, the results may nevertheless be regarded as a continuous series of determinations of the solubility of the fat in milk which had been kept from two to 109 hours. The solubility of the fat increased with the age of the milk, from 0·55 per cent in that kept for two hours, to 4·56 per cent in that kept during 109 hours, evidently in consequence of the destruction of the envelopes of the particles of butter, which had meanwhile been going on. It is probable that this solution of the coverings of the particles of butter is attended with oxydation, for the air of the vessels in which the milk was preserved contained less oxygen at the close than at the commencement of the experiment; from the experience of dairies it is also to be inferred that the solution of the envelopes of the particles of butter is retarded both by low and by high temperatures. Perhaps this solution is independent of the ordinary acid fermentation, but a more probable suggestion is that the envelopes of the fat globules may be the substance which excites the acid fermentation of the milk sugar, in one stage of which the caseine is coagulated.

The described solution,—or rather alteration, which the author proposes to designate as the "sweet fermentation (*Süsse Gährung*) of milk" must be of importance in explaining the rationale of the preparation of butter,—in which the chief object is to accumulate the fat particles without at the same time collecting any admixture of caseine.—*Journal für praktische Chemie*, lxxxii, 13, 1861, No. 1.

14. *Products from the combustion of Gunpowder under different pressures;* by B. F. Craig.—The perusal of the paper of Bunsen and Schiskoff on "The Chemical Theory of Gunpowder," whose publication about two years ago attracted much attention, (This Jour., [2], xxvi, 106), led me, as it no doubt did others, to make some experiments on the residues of exploded powder.

The investigations of the above-named chemists were made on the products of gunpowder which had been burned in small quantities, and under very slight pressure, and, in concluding their paper, they advance the supposition, that, under a difference of circumstances, the products may be essentially different from those which were obtained by themselves.

Such is actually the case, for the solution obtained by washing a gun with well boiled distilled water, immediately after its discharge, and filtering while hot, will be found to contain sulphuret of potassium with very small quantities of other substances, while Bunsen and Schishoff found their residues to consist mainly of sulphate and carbonate of potash. This difference is what was to be expected from our knowledge of chemical laws, and it is also to be observed that the products of combustion in the gun vary somewhat, according as the explosion takes place under a greater or less pressure. Thus in firing with a shot very heavy in proportion to the charge of powder, as in firing a mortar, the washings of the piece are found to be of a bright green color, while the ordinary washings of a gun are colorless after the suspended carbon has been allowed to settle, or has been removed by filtration.

The color above spoken of, is exactly the tint of a solution of a sesquisalt of chromium; it is not impaired by filtration of the liquid, but disappears in a few hours by exposure to the air, and immediately by the

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action of acids. The cause of this color seemed to me at first obscure, but I found that by adding a very minute quantity of freshly precipitated sulphuret of iron to solution of protosulphuret of potassium, the same color was produced, and a sensible trace of iron may always be found in gunpowder.

A greenish color is frequently observed when sulphuret of iron is precipitated in the presence of an alkaline sulphuret, but as it disappears on standing, it has been commonly attributed to the presence of particles of sulphuret of iron held in suspension, an opinion which must be erroneous, since I have obtained a solution of iron in sulphuret of potassium of an intensely green color perfectly clear and transparent, and permanent for many days in a sealed tube.

Why this green compound should be formed under some circumstances, and not under others, in a mortar, and not in a cannon, is not insusceptible of explanation.

It has been shown that when powder is exploded under slight pressure the alkaline metal remains in large part as a sulphate, but under higher pressure and corresponding temperature, it is reduced to the condition of a sulphuret. Now, by analogy, it would seem, that with the ordinary charges of a cannon or musket the iron is not reduced to the state of sulphuret, but if, as is often the case in a mortar, the projectile is fifty times the weight of the powder, or upwards, the gases are brought to a state of great tension before the shot moves, and in that state of things the carbon is completely converted into carbonic acid, and the iron, as well as the potassium, brought to the condition of sulphuret.

Smithsonian Laboratory, Washington, D. C., Oct., 1860.

15. *On the Amounts of Lead contained in some Silver Coins;* by Eliot and Storer.—The determination of the amount of lead in American silver coin was suggested to the authors by finding half of one per cent of lead in a sample of zinc such as is used at the United States mint for reducing chlorid of silver. (See their Memoir on the Impurities of Commercial Zinc in Memoirs Amer. Acad., [N. s.], viii, 61; also this Journal, [2], xxxi, 142). For the sake of comparison other coins were subsequently examined.

Kind of coin.	Per cent of Lead in the coin.
1 American half-dollar of 1824,	0·310
20 " five-cent pieces of 1853,	0·209
10 " ten-cent " of 1854,	0·228
2 " twenty-five cent pieces of 1858,	0·231
"Fine Silver" from the U. S. Assay Office in N. York, 1860,	0·161
1 Spanish dollar of 1793, Carolus IV,	0·056
1 Mexican " " 1829,	0·043
2 English Shillings of 1816,	0·485
1 French five-franc piece of 1852, Napoleon III,	0·428

On the supposition that the zinc used in the reduction of the silver is the source of the lead in the American coin, the authors calculate the amount of lead which would thus find its way into the coin. Their memoir, already cited, gives the per cents of lead found in two specimens of Vieille Montagne zinc; if zinc of the best quality (containing 0·292 per

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cent of lead) had been used, the silver coin would have contained 0·158 per cent of lead; if the second quality (containing 0·494 per cent of lead) had been employed, the coin would have contained 0·268 per cent of lead. Between these two limits all their determinations of lead in American silver coins lie. In offering this explanation of the occurrence of lead in American silver coin, the authors would by no means affirm that the zinc is the exclusive source of this impurity, for it is not at all improbable that a portion of the lead is derived from the leaden vats in which the reduction of the chlorid of silver is effected, or from the sulphuric acid which is used to excite the reaction. The process of analysis was such as to permit the separation of the gold contained in each kind of coin. A distinct button of metallic gold was obtained in every instance, before the blowpipe, but the amount of gold varied to a considerable extent; it was abundant in the American and Spanish coin, less was observed in the English and Mexican, and but little in the French coin or in the American fine silver. Brüel has remarked "that the process of separating lead and silver was less perfectly executed in the ages of antiquity than is at present the case." (*Karsten u. Dechen's Archiv. für Mineralogie, etc.*, 1844, xviii, 509), yet in none of the recorded analyses of ancient silver coins has any one detected so large an amount of lead as the authors have shown to occur in American fine silver of the year 1860, if a single analysis of Prof. Draper's be excepted which gave nearly three per cent of lead in a silver coin of Hadrian. It is probable however that the methods of analysis—none of which are recorded—employed for separating lead from silver by other chemists, were less delicate than those which the authors made use of and have fully described. The occurrence of lead in the American silver coin could probably be mainly, if not altogether, avoided, by employing zinc free from lead, such as is produced at the Zinc Works of Bethlehem, Pennsylvania. It is noteworthy that the American system of amalgamation, which has been so frequently criticised by European metallurgists, affords silver which is less strongly contaminated with lead, and is probably purer in other respects, than is produced by any other process of manufacture.—*Proceedings of the American Academy*, V, 52, Cambridge, Sept., 1860.

II. GEOLOGY.

1. *Botanical and Palæontological Report on the Geological State Survey of Arkansas;* by Leo Lesquereux.—This is a separate issue of the Botanical portion of the second Geological Report of Arkansas, just published, from p. 297 to 399, large 8vo, with five good plates representing new species of fossil plants from the Coal formation and one of fossil-leaves from the Tertiary. We regret that the separate title page is not dated. Considering that the operations recorded in this paper were made during a single, hasty, autumnal reconnaisance of the State of Arkansas, it is one of unusual interest and importance, and its plan may well be adopted for more thorough surveys under better auspices, especially as to what relates to the recent Botany, and general distribution of the plants of Arkansas. This part is introduced by the following appropriate—

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"*General Remarks.*—The distribution of the plants of a country, according to the nature of its geological formations, is extremely difficult to settle with any chances of reliability. It has been asserted with apparent reason:

1st. That it is still uncertain if the chemical elements of the soil, even if it was proved that they are directly depending on the nature of the underlying geological strata, have a perceptible influence on the vegetation which naturally covers any peculiar place. That, in any case, the amount of influence which the chemical constitution of the soil exercises upon the distribution of the vegetation is still problematical.

2d. That the geological elements, viz., the particles resulting from the decomposition of the rocks and entering into the composition of the soil, even if their influence on the vegetation were well marked, are generally disseminated by water and atmospheric agency to a great distance from the areas occupied by the formations from which they come. The lime of a limestone ridge, the sand of a mountain of sandstone are carried down the declivities, spread over other kind of rocks, transported to the alluvial plains, or deposited on the banks of rivers and thus mixed together in a peculiar compound which, in its new state, has but an indirect relation to the rocks from which it is derived, and no relation whatever to the formations which it covers. Moreover, the frequent alternations of strata of sandstone and of limestone which compose the rocks of the great valley of the Mississippi, Silurian, Devonian, Carboniferous, and Tertiary, prevent an exact limitation of the area over which each of them may extend its influence. Thus, it has been generally admitted that physical circumstances more actively govern the distribution of the vegetation of a country than can chemical constituents of the rocks. Consequently, that the direction of the ridges, the amount of light and atmospheric heat and moisture, the thickness of the soil, its hardness and capacity for retaining water, are the essential causes of the distribution of the plants.

These considerations may be true, but they touch only one side of a complex and difficult question which cannot be discussed now. If the hardness, compactness of a soil, its capacity for retaining water and heat, are essential causes affecting the distribution of the plants, it is evident that this cause depends principally on the chemical nature of the geological strata. On the other hand, if the dissemination of the geological elements renders the task of ascertaining their influence difficult in some places, it is not a reason to reject as useless or impossible any attempt to compare the vegetation of a country with its geological formations. If this comparison can be made anywhere with a chance of success, it is certainly in Arkansas, where the strata are nearly horizontal and extend over vast areas.

The exploration of the Botany of Arkansas began too late and was too short to permit the fulfilling of a work which for its completion would require some years of continual research. The following data collected along our road of travel can thus be considered only as the first points of delineating lines which may be continued and completed hereafter."

Under the head of the Mammoth Spring of Fulton County, Mr. Lesquereux notices the rank development of aquatic vegetation which it supports, owing to the temperature of the water, constantly 60° Fahr., and the amount of air it is surcharged with. It would be well to know what proportion of this air is carbonic acid. The short section on the prairies of Arkansas is of such general interest that we cite the whole.

"*Prairies of Arkansas.*—Before entering into the examination of the botanical distribution characteristic of the part of Arkansas which I explored, there is still a peculiar question which cannot be easily treated elsewhere, and which calls at once for an examination.

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The Prairies of Arkansas do not appear to have been formed all in the same manner. They are underlaid by different formations, situated at various elevations, and their general aspect differs apparently so much, that it looks as if a peculiar law had directed the formation of each of them.

I have explained elsewhere* the general formation of the prairies, and ascribed it to the agency of water. All the prairies still in a state of formation along the great lakes of the North are nothing else but marshes slowly passing to dry land by slow recession of water. When land is continually covered by low stagnant water, its only vegetation is that of the rushes and of the sedges. When the same land is alternately subjected to long inundations and then to dryness, during some months of the year, the same plants continue to cover it. By their decomposition these marshy plants produce a peculiar ground, either black, light, permeable when it is mixed with sand, as it is near the borders of the lakes, or hard, cold, impermeable when it is mixed with clay or muddy alluvium, as in some marshes underlaid by clay or shales, or along the banks of some rivers. Land continually covered with stagnant water cannot produce any trees, because the trees require for their growth, like most of the terrestrial plants, the introduction of atmospheric air to their roots. Neither do trees germinate and grow on a ground alternately covered with stagnant water and exposed to dryness for some months of the year. From these considerations, the law of the general formation of the prairies can be deduced: While a land or a part of a country is slowly passing from the state of swamp or marsh to the state of dry land the annual alternative of stagnant water and dryness causes the vegetation of peculiar plants, which, by their decomposition, form a peculiar soil unfavorable to the growth of the trees. From this general rule of formation, which regards only the prairies of the Mississippi valley,† all the different phenomena or peculiar appearances of the prairies can be easily explained.

The prairies of Arkansas, following their vegetation and their geological connection, may be separated into three classes:

1st. The prairies of the North, mostly underlaid by cherty limestone.

2d. The prairies of the West, on carboniferous shales and clay.

3d. The prairies of the South and East, overlaying tertiary and alluvial formations.

1st. The limestone prairies of North Arkansas mostly belong to the counties which are examined in the next division. They are singular in this fact, that their surface is not always flat, and that they are mostly placed on soft declivities or coves along or between the ridges. They are mostly of small extent and surrounded by thickets of low trees. The compact or somewhat porous Subcarboniferous Limestone which they cover does not absorb water with rapidity. Hence, in the spring, water percolates slowly along the slopes, taking with it the detritus of the stone, and depositing it where its course is either stopped or slackened. A scant swamp vegetation springs up there, its decomposed remains are mixed with the original deposit, which, by and by, augments in thickness under the action of water and of vegetation. This soil is naturally spongy, preserves water for a part of the year, like the peat, which it resembles, and thus cannot sustain trees. They establish themselves on a firmer ground all around. When by successive contribution of limestone deposited by water and of particles of humus received from the plants this soil has become thick enough, it is, when drained by a few ditches (serving as channels for the water of the rainy season), a fertile and easily cultivated ground. The channels of drainage are generally formed by a natural depression, the depth of which varies with the thickness of the soil of each prairie. In this case, as coarser materials are of course heaped on the banks of these creeks, a few

* Bulletin of the Society of Natural Sciences of Neuchatel (1856).

† The prairies of the far West, along the eastern base of the Rocky Mountains, are true sandy deserts, caused by the dryness of the atmosphere.

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trees grow along them. They are mostly stunted specimens of the Post-Oak, the Rock Chestnut Oak, the Persimmon, the Mockernut, the Juniper, and a shrub, *Bumelia lanuginosa*, Pers. The characteristic herbaceous plants of these limestone prairies are especially: *Ambrosia polystachya*, *Kuhnia Eupatorioides*, *Aster sericeus*, *Croton capitatum*, *Grindelia lanceolata*, *Palafoxia callosa*, *Oxibaphus albidus*, &c., species which are not found on the prairies of other formation. Besides these plants they are covered with a great number of species belonging to the prairies in general.

Between this and the second division of the prairies, viz., of those which are formed on the Carboniferous shales and clay, there is a remarkable transition, which unites both divisions, or rather shows their common origin. In the western parts of Benton and the northern part of Washington counties some flat prairies, formed like those of the second division, and underlaid by shales or red clay, have still at their surface some isolated patches of Subcarboniferous cherty limestone, which appear here and there, breaking the general horizontality like small mounds. Possibly these low mounds could support the vegetation of the trees, and they may have been transformed into prairies by the influence of fire, which is a secondary agent of their formation. But the soil which covers them is exactly of the same nature as the soil of the surrounding prairies, and as their height is no more than two or three feet, they may have been formed in the same manner and by the agency of water.

The prairies on the Carboniferous shales are generally flat, surrounded by hills, or at least by a higher border, which gives them the appearance of the bottom of drained lakes. These prairies are of various extent, and although they may overlie different kinds of ground or geological formation, in Arkansas they are generally underlaid by Carboniferous fire-clay or shales. In the spring they are covered with water which cannot percolate, and become true marshes for a time, and have the vegetation of marshes: the rushes and the sedges. This semi-aquatic vegetation gives, according to the nature of the underlying strata, either a hard, compact, cold soil, by decomposition of shales or clay; or, when mixed with sand, the peaty black soil of the prairies of Illinois and of the Northern States. In the summer months, these marshy prairies become dry by evaporation, and as it happens with the prairies of the first section, the alternative of too much water and of dryness in the soil prevents the growth of trees.

These prairies are more sterile or rather more difficult to cultivate than those of the former section, as we shall have occasion to see when examining the counties of Sebastian, Franklin, &c., where this kind of prairie is mostly found. A few trees,—the Water Oak, the Pin Oak, the Honey Locust,—grow along the creeks which meander in their middle. The soil is, in its natural state, mostly covered with the great Compositæ of the prairies and the hard grasses, species of Beard-grass and Broom-corn.

The prairies of the third class are extensively formed in Arkansas on the Tertiary or Alluvial land bordering some rivers of the South, especially Red River. Our exploration did not extend to that part of the State. It is very probable that these prairies have been formed in the same manner and by the same agency as those of the other sections. From the catalogue of Mr. Nuttall, who explored these plains, their plants appear somewhat different from those of the other prairies. They rather bear the character of a Western Flora, or of the Flora of the plains extending toward Mexico."

Then the geological nature of the soil, and the general characteristics of the vegetation, the agricultural capabilities, &c., of different districts of the State are considered in succession, and lastly, there is a catalogue of the plants of Arkansas, as far as known, systematically arranged, their Latin names, their English names, Geological station, and natural hab-

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itat, being given in parallel columns, with well-chosen remarks upon properties and uses appended in foot notes.

The Palæontological part, noting that all the coal-beds of the State appear to belong to the lowest member of the Coal-formations, briefly mentions the characteristics of different beds examined, and describes 18 new species of plants from their overlying shales, and enumerates 50 others which have been elsewhere found. Leaves of a new supposed *Magnolia*, of a *Rhamnus*, and of a *Quercus*, are described and figured from a tertiary deposit. A. G.

2. *Prof. Heer's reply to Dr. Newberry on the Age of the Nebraska Leaves.*—The article of Dr. Newberry in this Journal, xxx, p. 273, having a few days ago come to my notice, calls for an answer from me, although it is with great unwillingness that I enter into controversy.

The point of dispute is known to be on the plants discovered in Nebraska. Dr. Newberry had remarked in relation to them (cf. *On the so-called Triassic rocks of Kansas and Nebraska by Meek and Hayden, this Journal*, [2], vol. xxvii, p. 33); 'the species of your fossil plants are probably all new, *though generally closely allied to the Cretaceous species of the old world*,' and, to prove this, he quotes the following genera: Sphenopteris, Abietites, Acer, Fagus, Populus, Cornus, Liriodendron, Pyrus?, Alnus, Salix, Magnolia, Credneria and Ettinghausenia. I took the liberty of remarking, that according to my views, the two last named genera were not correctly defined, and that the rest of the genera, quoted by Dr. Newberry are represented in the Tertiary and not in the Cretaceous. On this Dr. Newberry founded his charges, which, though answered already by Mr. Lesquereux, he repeats again. I allow myself to reply to them as follows:

1. In relation to the Credneria Dr. Newberry seems now to admit, that the leaves from Nebraska cannot be assigned to this genus, as he himself says: it may prove a new genus. In fact, all the characteristics of Credneria are wanting in these leaves, (to wit: those fine lateral veins, which stand out rectangular, proceeding from below the rigid secondary veins.) This very characteristic caused Mr. Stichler to compare them with Coccolaba, whilst the leaves from Nebraska are very similar to those of *Populus leuce*, Rossm. sp. In this comparison I had not only examined the drawings of Rossmæssler and Unger, but also fine leaves of that species which were sent to me from Bognasco and Sieblos. The margin of these leaves is only sparingly dentate or even entirely toothless, and also only slightly wavy or undulate. I cannot agree to Dr. Newberry's Ettinghausenia any more than in regard to the Credneria. All the leaves of this genus, which are known to me, are serrate or dentate toward the apex, the leaf from Nebraska, on the contrary, has its blade divided into three lobes, and these have an even margin. This leaf seems to me rather to belong to Sassafras, of which genus Massalongo has one species presented in beautiful plates (in his *Studii della flori fossili del Senegagliense*). The same species (*S. Feretianum* Mass.) I have received from Merat, only the lobes in this are much shorter; of a second species (*S. germanica*, M.) I have a representation in my work on the flora of Skopau (cf. *Beiträge zur Flora des sachs. Braunkohlen*). A comparison of the drawings of the Nebraska leaf (in the Proceedings Acad. Nat. Sci. Phil-

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adelphia, Dec. 1858, p. 223, Fig. 3,) with these Tertiary Sassafras species, and also with the Ettinghausenia, will satisfy every one that it is much more like the former and probably, therefore, is to be assigned to that genus. In relation to the separation of Ettinghausenia from Credneria, I did not intend to pronounce it in my letter to Mr. Lesquereux as unjustified. But Mr. Stichler certainly will willingly concede, that with the present materials it is impossible to establish this genus in a satisfactory manner; for Mr. Stichler himself has found cause to add the sign of interrogation to more than half of the species, mentioned by him among the Ettinghausenia. Dr. Newberry's assigning such a deviating form of leaf to this genus, proves the correctness of what I have said. Mr. Stichler has characterized excellently and circumscribed more strictly the genus Credneria, and separated from it a number of deviating leaves, which put us more in mind of Cissus, and has united them under one common name (as Mr. Bronn has done already before him). But at present it is impossible to characterize in a satisfactory manner this group of leaves, which itself seems to embrace very different elements. Wherefore it can justly be said, that this genus has no value whenever it is desired to fix the age of a certain formation, while, on the contrary, the several species of it may be of great importance in the decision. Therefore, I do not think that I have done injustice to Mr. Stichler by my having said so much in a letter to a friend, which letter was not intended for publication. That Dr. Newberry feels himself called on to appear as the defender of Mr. Stichler amuses me. The thought of offending Mr. Stichler never entered my mind, having lived for years in habits of friendly scientific intercourse with him, and holding his works in the highest esteem.

2. But if the Credneria and Ettinghausenia are now left out of the flora of Nebraska, and if the leaves so interpreted belong rather to the Tertiary than to the Cretaceous genera, the question may be put, on what grounds can the assertion of Dr. Newberry be established: that these plants ally themselves closely to the Cretaceous species of the Old World? As we remarked above, Dr. Newberry mentions besides Credneria and Ettinghausenia, eleven other genera, to the list of which he afterwards adds Platanus. These are all, however, well known Tertiary genera and several of them bear an important part in the Tertiary flora. Two of them (*Sphenopteris* and *Abietites*) are not of any importance in this discussion, being present in nearly all the formations and therefore not peculiar to any one of them; but this is not the case with the rest of them. Dr. Newberry now maintains, that several of these are contained in the work of Stichler (*über die Kreideflora des Hayes Palæontographica*, v, 23), and puts the alternative that either I have not known the work of Stichler, and am, therefore, not competent to give an opinion upon it; or I have known it, and a severer expression would be justified. To this I have to reply, that Mr. Stichler, in the work mentioned, describes only the genera: Credneria, Ettinghausenia, Weichselia, Pandanus, Pterophyllum, Delesserites, and mentions *Salicites? fragiliformis*, etc., and *Juglans Humboldtiana;* but in the introduction, (p. 50), he mentions, that Mr. Apothecary Hampe gives the following additional genera: Chondrites, Halymenites, Equisetum, Pecapteni, Flabellaria, Pinites, Geinitzia, Arau-

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carites? Comptonites, Salicites, Populus, Alnites, Acer? and Quercites. Mr. Stichler, however, says, (p. 50), *that most of these vegetable remains need further examination, which was not possible, until more perfect specimens were on hand, and he enumerates expressly certain insufficiently determined genera:* viz. Comptonites, Salicites, Populus and Alnites. Mr. Stichler, therefore, does not enter into those at all, although his work treats on the very flora of this locality, and this evidently only for want of material for a description in any way adequate. These are precisely the genera to which Dr. Newberry refers, and for which he reproaches me, as either not having taken notice of, or else of willingly ignoring them. I confess freely, that in my opinion it is not possible to build such important conclusions on such uncertain data, and that it were better to lay them aside until a somewhat more correct solution is possible. But if, for argument's sake, we should accept these definitions of Mr. Hampe, based upon incomplete materials and pronounced unsatisfactory by Mr. Stichler himself, Dr. Newberry's position is not thereby bettered, as that list contains only two of the genera mentioned by him, Populus and Acer, and this last one, Stichler himself designates immediately afterwards as Acerites? That Acerites is not the same as Acer, Alnites not Alnus, and Salicites not Salix, it is surely not necessary to argue any further at present. They designate only similar forms of leaves, which, however, are so incompletely preserved, that a stricter definition could not be formed, as Mr. Stichler himself shows, that Salicites fragiliformis is not a proper Salix, but is better to be designated as Phyllites. It is true, Messrs. Gœppert, Reuss and Dunker mention saliciform leaves in the Cretaceous formation, but in none of all the now known species are the veins sufficiently preserved to enable us to recognize in them the characteristics of the Salix: the definitions, therefore, have to remain yet unsettled.*

Mr. Ettinghausen is of the same opinion; (cf. *über die Proteaceen der Vorwelt, S. 8*), according to him *Salicites angustus* Reuss belongs to *Grevillea*, *Comptonites antiquus* Nils., however, to *Dryandra*. Thus stands the matter in relation to those genera, which, according to Dr. Newberry, Nebraska has in common with the Cretaceous formation. Six of Dr. Newberry's genera, however, (Fagus, Cornus, Liriodendron, Pyrus, Magnolia and Platanus), are not mentioned at all, either by Mr. Stichler, or in any work on the Cretaceous flora. Therefore, I do not feel that I deserve the reproaches of Dr. Newberry, while at the same time I consider myself justified in declaring again, on the present occasion, that the very genera mentioned by Dr. Newberry himself argue in favor of the Tertiary flora and not of the Cretaceous, and that, consequently, his assertion, that the Flora of Nebraska is closely allied with the Cretaceous of Europe, is not supported by the evidence. It is entirely incomprehensible to me,

* The *Salicites Hartigi* Dunk., cannot belong to Salix: not only are the shortened lateral veins different, but also the terminations of the secondary veins. In Salix they form arches, not reaching the margin, while in these Salicites (at least in the drawing), they reach the margin. *Salicites Potzeldianus* Gœp., (Nov. Act. Acad. Lœp. xix, t. 47; fig. 18), Mr. Gœppert himself considers as very dubious. In this species occur also those shortened lateral veins characteristic of the willows. *Carpinites arenaceus* Gp., (l. c. Taf. 47, fig. 19, 20) cannot be compared with Carpinus; the secondary veins terminate in arches.

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how he can say "the fossil flora of Blankenburg is indeed strikingly like that of our lower Cretaceous strata," (this Journal, [2], xxix, p. 211),—a flora so wholly different from the present European and American, while living representatives still occur in America of nearly all of the now known genera of the flora of Nebraska.

3. If the relations of the strata and the fossil remains of animals make it indubitable that the fossiliferous sandstone in Nebraska and Kansas belongs to the Cretaceous formation, it follows of course, that these plants have to be assigned to the Cretaceous flora. In this case the interesting fact would present itself, that the Cretaceous flora of America differs entirely from that of Europe, and is more closely related to that of the middle Tertiary. The Coal flora of America corresponds in many of its most important types with that of Europe, as shown by the excellent works of Mr. Lesquereux, likewise the flora of the Keuper, as we learn from the distinguished labors on these plants by E. Emmons; further, the Miocene flora of Vancouver shows the most striking relationship with the Miocene flora of Europe; the Cretaceous flora, therefore, would form a remarkable exception. We must, of course, not forget, that the Cretaceous flora of Europe has not been as yet extensively examined, and that many new forms will doubtless yet come to light. The Tertiary flora shows such an abundance of Dicotyledons, that in all probability many more of its typical genera than are known at present have their original forms in the Cretaceous epoch, among them, perhaps, some of those which came to our knowledge from Kansas and Nebraska. It is, however, worthy of notice, that the Eocene flora of Europe, (i. e., that of Monte Bolca, of the Isle of Wight, of St. Zacharie in Provence, and of Skopau), does not contain those genera mentioned by Dr. Newberry (with the exception of Acer), and that they do not make their appearance in Europe before the lower Miocene epoch, while, on the other hand, they are entirely missing in Aix, the richest spot for Cretaceous plants known, although the sands and clays of Aix belong to the upper Cretaceous formation (*Turonienne*); wherefore we must suppose here a nearer approach to the Tertiary flora, than in the lowest Cretaceous, to which the formation of Nebraska is said to belong. The materials before us enable us to assert, that the Cretaceous flora of Europe has an entirely different character from that of Nebraska, and I will try to prove this more satisfactorily.

We have in the Cretaceous flora of Europe, numerous and mostly peculiar Filices, differing in type from the present European forms. We notice among them beautiful Gleicheniaceæ, (one genuine Gleichenia), and large Panæaceæ, among which the superb Weichselia reminds us of Anomopteris of the varigated sandstone, and which, with several more extinct genera, (Moriconia, Benizia, Bonaventura, Manheimia, etc.), gives the Cretaceous forms a peculiar feature. Among Monocotyledons we meet Palms, Pandaneæ and Scitameneæ, (Cannophyllites); among the Gymnospermæ also a considerable number which remind us of the Cycadeæ of the Jurassic flora, (Cycadites, Pterophyllum, Pterozamites, Microzamia and Zamiostrobus), and numerous peculiar Coniferæ, of which the genus Cycadopsis, (*Geonitzia*), related to Sequoia, has spread very largely. With this, and with those forms which are closely allied to the Indio-Australian

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Damareæ, Cunninghamieæ and Arancariæ, are mixed (according to epistolatory communications from Dr. Debeg), several most peculiar extinct genera; the Dicotyledons, which, as is well known, appear first in the Cretaceous formation, present themselves in the lower chalk only in few, (namely in Credneria and Ettinghausenia), but in the chalk of Aix, in numerous species. According to the communications from Dr. Debeg, to whom we owe an excellent work on these plants, (cf. *die urweltlichen Thallophyten und Acrobryen, Denkschriften der Wiener-Academie*, xvi, and xvii), he has discovered in Aix about 200 species of Dicotyledons. Among them are prominent the Proteaceæ, (60–70 species), Grevillea, Hakea, Banksia, Persoonia, and some other Dryandreæ, appearing among them; but also the Myrtaceæ, are pretty numerously presented, (Eugeniæ, Eucalypti, and Leucospermum), whereas the Leguminosæ are entirely wanting. Among the Amentaceæ appear the genera Ficus and Quercus, and of the Juglandeæ Gœppert has already made known the fruit of a walnut-tree. But those leaves also described by Dunken as Cytisus [Cretaceous] belong in my opinion to Juglans and Carya.* This flora of Aix shows, therefore, a decided Indio-Australian character, and approaches thereby the Eocene flora, while that of the older Chalk formation is foreshadowing the transition to that of the Jura. How different the flora of Nebraska appears, having all the now known genera in common with the Miocene flora, and all the dicotyledoneous generic types met in America at the present time! If it really belongs to the oldest Chalk formation, the flora of that epoch would closely ally itself to the present flora of America, and there had (judging by the small amount of materials) since that time not occurred any new arrangement which had materially changed the genera, while this was the case in Europe in a high degree. Many peculiar forms join the older Jurassian types in the lower Chalk, and the Dicotyledons appear mostly in now extinct genera; after this the flora assumes more and more the Indio-Australian character, which continues through the Pliocene flora to the commencement of the Miocene; then the Indio-Australian types retreat by degrees into the background, making room for the American, this prevailing to the end of the Miocene epoch, and, in single species, reaching into the Pliocene, while in the Quaternary epoch the Asiatic types make their appearance, with the present creation, predetermining the character of the vegetation. No doubt it is possible, that the American flora has assumed from the Cretaceous period an entirely different development from that of Europe; but ere we accept such a remarkable phenomenon as a fact, we had rather wait for further examinations of the localities where the Nebraska leaves are found. I must confess that I cannot suppress my doubts about the correctness of the classification of them, and I appeal to the experience we have had in Europe. How easily accessible are our Alps in comparison to the parts of America in question, and how long a time did it take, before we were correctly informed on the relations of the strata of the most important formations; and how much are we in the dark yet about some parts of those very mountains! It is now generally admitted, that with us older formations are resting on Tertiary for an extent of over 36 miles. "There

* They cannot belong to Cytisus, because the secondary veins project too much; they have, however, the character of walnut-leaves.

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exists," says Studer, (*Geologie der Schweiz*, ii, f. 4), "in this mountain group of several square leagues, the wonderful arrangement, that Flysch and Nummulite-sandstones, which we have learnt to recognize as the last sediment-formation in the system of the Alps, here appear in the foundation of the Verrunaco, of the Jura and of the Chalk-formation, not otherwise as we are used to see gneiss and mica-slate in other parts of the Alps or in the palæozoic formations in other mountain systems." If Dr. Newberry could visit the Glärnisch, (Canton Glarus), on the eastern slopes of which true Jurassic to a great extent lies over nummulitic chalk in a nearly horizontal position, he, perhaps, also would find, that, without the shadow of a doubt, one must believe the Nummulitic-chalk older than the Jura.

I cannot close this note without expressing my deep regret for having been obliged thus publicly to defend myself against Dr. Newberry. There are so few men engaged in the study of fossil plants, and the field is so immensely extensive, that it would be better to devote our time to this work, and not to useless disputes. I have, however, not sought this discussion, and only entered into it compulsorily; and I hope that in future I may meet Dr. Newberry, who has already rendered to science such important services, on more pleasant grounds. OSWALD HEER.

Zurich, Dec. 15, 1860.

3. *On the causes which gave rise to the generally elongated form and parallel arrangement of the pebbles in the Newport Conglomerate;* by Prof. WILLIAM B. ROGERS (from Proc. Boston Sci. Nat. History).—Referring to the characters of the conglomerate as presented at Purgatory and other places in the vicinity of Newport and indeed generally throughout its outcrops, Prof. Rogers commented on the hypothesis by which it had lately been proposed to explain the elongated form and parallel arrangement of the pebbles in the massive strata of the rock. He described the steep and alternating dips of these thick beds of conglomerate at and near Purgatory, as made apparent by the occasional layers of interposed sandstone, and pointed out the general parallelism there and elsewhere of the flat sides of the pebbles to the planes of deposition as well as the prevailing uniformity of direction of their larger axes.

He urged that such an arrangement of the pebbles corresponds precisely with the effects of *wave and current action* on water-worn and partially water-borne fragments during their accumulation. The large proportion of pebbles of elongated shape met with in these beds was, he considered, the natural consequence of the mode of disintegration of the original metamorphic rocks from which the pebbles were derived. Such rocks, in virtue of sharply intersecting joints and cleavage planes are prone in many localities to break up in long irregular somewhat rhombic figures which by the wearing action of streams and tides are easily converted into oblong pebbles like those of the Newport conglomerate. Examples of this mode of disintegration are common in the more altered belts of the Appalachian region, especially among the silicious and argillaceous slates along the southeastern border, and may be seen at various points among the similar altered rocks of New England.

To the hypothesis of Prof. Hitchcock (see Prof. H.'s paper in this No.) that these elongated pebbles owe their peculiar shape and position to the

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action of powerful pressure upon the strata while the pebbles were in a soft condition from intense heat or other causes, Prof. Rogers urged the following objections:

1st. The effect of pressure upon a plastic solid, as shown by Sorby and Tyndal, is in all cases to develope more and more distinct cleavage planes throughout the mass, these planes being uniformly at right angles to the direction of the pressing force. Such an action applied on a large scale to the strata of conglomerate must therefore have had the effect not only of flattening the plastic pebbles in a uniform direction, but of developing a cleavage or lamination in them all, parallel to their flat sections as they lie in the mass. But this is so far from being the fact that we find the cleavage planes of different pebbles running in wholly different directions, sometimes across, sometimes parallel, and sometimes oblique to the general bedding, just as might be expected from the preservation of the original cleavage-structure of the rock from which they were derived.

2d. Such a moulding of the pebbles by pressure would either enormously distort or entirely obliterate any fossil forms or impressions which may have existed upon or within the pebbles at the time of their deposite. But an inspection of the Lingulæ from the Taunton River conglomerate and of a similar fossil found subsequently by Mr. Easton in the conglomerate of Newport shows that no such violence could possibly have operated on the mass.

3d. While in the localities referred to the *majority* of the pebbles have the oblong shape and parallel arrangement above described, there are many scattered through the mass, which are either nearly round or have their longer dimensions more or less transverse or even perpendicular to the general direction. As these could not have escaped the enormous, all-pervading, softening action and pressure which the hypothesis assumes, their presence in these discordant conditions seems of itself a sufficient refutation of the theory.

In regard to the curved form and close adaptation observed in some of the pebbles, Prof. Rogers thought that accidental peculiarities of shape in the original fragment and the effects of attrition and the close packing of the accumulated deposit furnished an adequate explanation both of the bent form sometimes met with and the accurate fitting of the contiguous pebble to the concave surface.

As an example of the formation of flattened pebbles by the action of the shore waves, Prof. Rogers referred to the paving stones of slaty trap recently imported from Newfoundland, which are remarkable for their very uniform circular outline, their smooth, slightly convex faces and a thickness rarely exceeding one-third of their breadth. If we suppose a great mass of these, as they lie piled along the shore with their broad sides horizontal, to be hereafter cemented together as a stratum of conglomerate rock, would not the argument founded on their shape and position be even stronger than in the case of the Newport conglomerate? Yet nothing is more certain than that they owe their shape and arrangement to the peculiar movement and attrition to which they have been subjected by the action of the waves.

Thus as regards the Newport rocks and most other conglomerates which had fallen under his notice, Prof. Rogers saw no difficulty in refer-

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ring the form and arrangement of the pebbles to the familiar agencies indicated. He does not however doubt that in some highly metamorphic districts, conglomerate rocks are to be found which have sustained great internal changes through the effects of heat, chemical action and violent pressure. Such he has long thought must have been the conditions in some parts of the Blue Ridge and South Mountain chain in the Middle States, and such perhaps were the influences which operated on the Gneissoid conglomerates of the Green mountains, to which Prof. Hitchcock has referred in his recent communication to the Society.

MINERALOGY.—

4. *Note on Chloritoid from Canada;* by T. STERRY HUNT, F.R.S.—Among the crystalline Palæozoic schists of the Notre Dame Mts., which are the Canadian prolongation of the Green Mts., of Vermont, is a rock characterized by the presence of a mineral which has been designated in the Reports of the Survey by the name of phyllite, from the supposition of its identity with a similar mineral from Massachusetts, described, named and analyzed by Thompson. The mineral in question is abundant in a fine grained grayish wrinkled micaceous schist from Brome and in larger specimens from Leeds; where it occurs in a similar rock which is pearl gray in color, passing into greenish gray, and contains a large proportion of quartz with a mineral talcose in aspect, but aluminous in composition, and apparently micaceous. Similar micaceous schists containing the mineral in question may be traced in the continuation of the Notre Dame Mts., as far as Gaspé. In the rock of Leeds the phyllite occurs in small lamellar masses rarely more than one-fourth of an inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter composed of radiating lamellæ and sometimes making up one-half the volume of the rock. In most localities however the masses are smaller and less abundant. The mineral has a perfect cleavage in one direction and two less distinct transverse cleavages, 'the lamellæ are often curved and are not easily separable. Hardness 6·0, density 3·513, color dark greenish-gray to black; brilliant black on the surfaces of perfect cleavage which have a vitreous lustre; the cross-fracture is granular and exhibits a feeble waxy lustre. The streak and powder are greenish gray. The mineral resembles somewhat a dark colored variety of hypersthene.' The analysis of a carefully selected specimen from Leeds gave as follows:*

Silica,	26·30
Alumina,	37·10
Protoxyd of iron,	25·92
Protoxyd of manganese,	·93
Magnesia,	3·66
Water,	6·10
	100·01

This analysis shows the mineral to be chloritoid, with which its specific gravity and other characters agree. It is the *barytophyllite* of Breithaupt, the *masonite* of Jackson and the *sismondine* of Delesse. All of these minerals occur in argillaceous, micaceous or chloritic slates and

* Report of Geol. Survey of Canada, 1858, p. 194.

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having a hardness of 5·0—6·0, and a density of 3·45—3·57, have been united with chloritoid, with which they agree in composition. (Dana, *Mineralogy*, ii, 298).

The phyllite of Thompson according to the analysis of that chemist contains a larger amount of silica than chloritoid together with more manganese, and 6·80 p. c. of potash, but having had occasion to repeat several analyses of this chemist, I have found that his determinations of alkalies are entirely erroneous. Thus in the case of raphyllite a tremolite containing only traces of alkalies he indicated more than ten per cent of potash and in his retinalite, a pure serpentine, nearly nineteen per cent of soda.* In both cases the error was at the expense of the magnesia of the mineral. The substance examined by Thompson has not so far as I know been examined or identified by American mineralogists, but in the minerological cabinet of the Laval University at Quebec, is a specimen from the collection of the late Mr. Heuland; said to be phyllite from Massachusetts, which is evidently chloritoid, and cannot be distinguished from the specimens of that mineral just described; the rock is also apparently identical.

The ottrelite of Haüy, to which Dana has referred the phyllite of Thompson, occurs in an argillaceous slate in Belgium, and in a specimen before me cannot be distinguished from the phyllite from Massachusetts or the chloritoid of Canada. This mineral has however been analyzed by Damour, whose name is a guarantee for accuracy, and differs from chloritoid in containing a considerable excess of silica, which might possibly be derived from the gangue. The specific gravity which Damour has assigned to ottrelite is 4·4—which is so extraordinary for a mineral of that composition that we are led to suspect some error probably of the press or pen. The question of the identity of ottrelite with chloritoid is one which requires farther examination. Meanwhile the latter mineral assumes some importance to the lithologist as characterizing over wide areas considerable masses of schists, which we have elsewhere described as chloritoid slate.

III. BOTANY.

1. *Journal of the Proceedings of the Linnæan Society; Botany.* No. 18 (1860), contains, (1.) Notes on *Ternstræmiaceæ*, by George Bentham, V.P.L.S. A critical survey of the order (for which we could have wished that the name *Camelliaceæ* were adopted), in which Mr. Bentham retains the *Saurauieæ*, and to this refers *Stachyurus*, very properly reducing *Draytonia* to *Saurauia;* also the *Gordinieæ* or proper *Camelliaceæ*, and the *Bonnetieæ*, to which he joins the genus *Marila;* and finally he makes of the *Marcgraviaceæ* another tribe of the same order. The known species of *Cairapa* are described in a note, with several other new plants of Spruce's collection.

(2.) Mr. Crocker, a foreman in Kew Gardens describes the curious germination of *Streptocarpus polyanthus* and a few other *Cyrtandreæ* of similar peculiarities. In the adult state, the plant above mentioned has only one leaf,—a radical one—and this, as Mr. Crocker shows, is one of the cotyledons, which from a microscopical size expands in germination

* Report of Geol. Survey of Canada, 1850, p. 40.

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and at length becomes about a foot long, the flowerstalks springing from its sinus. The two cotyledons grow equally for the first few days, but one of them is soon arrested while the other grows on in this remarkable manner. *S. Rexii* and *S. biflorus* show this remarkable peculiarity, but also develope a plumule of two or three smaller leaves.

(3.) The Notes on *Anonaceæ*, by George Bentham, indicate the principles adopted in the forthcoming revision of this order for the new *Genera Plantarum*, and characterizes several new species. The rather numerous instances in which the petals are imbricated in æstivation, as in *Magnoliaceæ*, are mentioned, and the æstivation is (perhaps rather too much) used in the division into tribes.

(4.) *Botanical Memoranda*, by George Bentham. In this short paper Mr. Bentham discusses several topics with his well-known ability and good sense. We must demur to his conclusion that the so-called involucre of *Anemone* answers to a single amplexical divided leaf, and would refer to the involucels of two opposite leaves in *A. Virginiana* and *A. Pennsylvanica* in proof of the contrary; nor can we regard the change from alternate to opposite or verticillate leaves as so anomalous or so unusual as in itself to give likelihood to the new hypothesis. The more elaborate ensuing note on the stigmas of *Papavaraceæ* is clear and admirable.

(5.) On *Fissicalyx*, a new genus of *Dalbergieæ* (No. 2223 of Fendler's Venezuelan collection), by the same author.

(6.) Account of the plants collected by Dr. Walker in Greenland and Arctic America during the expedition of Sir Francis M'Clintock in the Yacht 'Fox,' by Dr. J. D. Hooker.

(7.) *Hepaticæ India Orientalis*, by Mr. Mitten; commenced.

Supplement to vol. v.; *Botany*, 1860, contains the *Florida Adenensis*, by Dr. Thomas Anderson, a botanist of excellent promise; 43 pages, with 6 plates. Ninety-four species compose the known phænogamous flora of this arid little peninsula of Aden, belonging to 79 genera and 41 natural orders. Most of these species are scarce in individuals, only a few of the more arid forms predominating; all are more or less peculiar in their habit, and destitute of a bright green color; nearly all are glaucous, whitened, or hoary, many are fleshy, and 16 bear sharp thorns. "All the species have to strive against conditions tending to the entire extinction of vegetable life;" and "the flora appears to be a collection of desert species, selected from widely different natural orders and genera, and all alike contending with the excessive heat and drought." "In so dry a climate, Ferns and other Cryptogamia except Lichenes, are quite unknown." A. G.

Review.—

2. *Life on the Earth, its Origin and Succession;* by John Phillips, M.A., LL.D., F.R.S., late President of the Geological Society of London, Professor of Geology in the University of Oxford. Cambridge and London, Macmillan & Co., 1860, pp. 224, 12mo.—A book with this taking title, especially in these days, is sure of a prompt and wide circulation,—all the more so when the author is an Oxford Professor, and a Rede Lecturer at the sister University. The subject and the author here command attention and respect, and excite a high degree of expectation. We imagine that those readers who take this volume for what it really is, viz.,

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an amplification of "the Rede Lecture," delivered in the year 1860, before the University of Cambridge, and as a popular exposition, by an able geologist, of an interesting scientific topic—will not be disappointed.

On the other hand, those who take it,—as the title-page might lead them to do—either for an original speculation upon the Origin and Succession of Life on the Earth, or for a serious and sustained criticism of the particular hypothesis which Mr. Darwin has recently propounded, will hardly have their expectations satisfied. Yet, along with a large amount of very good elementary exposition, some considerations are adduced, and some points are made, which are extremely noteworthy, and which show how well Professor Phillips could have discussed the whole subject, at least in its geological bearings, if he had seriously undertaken it.

The best point, as it strikes us, which Professor Phillips makes against Darwin is drawn from a comparison of fresh-water with marine Mollusca,—the latter of numerous and widely diversified types, and of great change on the whole from age to age; the former of comparatively few types, and much alike all over the world and throughout geological time as far back as they can be traced.

"If, in either of these cases, the Unionidæ, the Paludinadæ, the Limnæadæ, Planorbes, Physæ, &c., the modern forms are derived from the ancient, we have the full measure of the whole variation,—the differentials of change are all integrated by time, and we behold the sum—how little! But if not so, if the modern and ancient species have sprung from different branches of a stem still older than either, how much stronger, if possible, is this decisive testimony against the doctrine of indefinite change through time and circumstance! Circumstances have varied, ages have passed away, and yet every generic group exhibits at every step the same essential characters, and many of the little peculiarities, such as eroded beaks, plications on the surface, reflexions of the lip, carinations of the whorls, which cannot be consistent with accumulated tendencies to change, (p. 113). "The discovery of a land-shell allied to if not identical with Pupa, in the interior of a fossil tree (Sigillaria) in the coal-formation of Nova Scotia," (p. 116), is an analogous case.

To enforce the argument we need the statement,—which we wonder Prof. Phillips has not adduced, and which we suppose may be safely ventured upon,—that fluviatile and terrestrial conditions must all along have been more variant and diverse, and therefore more favorable to the eduction and natural selection of variations according to the hypothesis, than marine. Yet while, under the comparatively uniform conditions of the latter, every thing 'doth suffer a sea-change into something rich and strange," the freshwater and terrestrial genera remain almost unaltered. Put in this form, the objection appears to us a formidable one, which we should not know how to answer. Yet, on the whole, there is, as there should be on the theory, a far greater diversity on land than in salt water. The common form of similar objections misapprehends the theory, by assuming that actual variability is something constant and equable—a uniform and measurable force acting always and upon entire species—so that so much time should bring to pass so much change; or else, that the external conditions really produce the variation;—while, also, that *com-*

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plex which is condensed and rather boldly personified by the term Natural Selection is no better comprehended by many naturalists than is the Malthusian theory by many political economists.

In view of the fact that a large number of existing species appear (by the evidence of their remains) to have existed from near the beginning of the pleistocene or quaternary epoch, and that the difference between the fauna of that period and the present consists merely in the extinction of a number of species, Mr. Pictet convincingly argues that the actual geological epoch, the present creation, began at the close of the tertiary. Professor Phillips would seem to go farther; for, in view of the similar, though less universal identifications by which "the tertiary series is linked in easy harmony with the actual period," he concludes that; "The present age is in fact a part of the great cænozoic period," (p. 169, 170), under which term, as the preface informs us, he "comprehends not only the eocene, miocene, and pleiocene of Lyell, but the whole series of supra-cretaceous deposits." Looking then at "examples of parallel forms of Mammalia now living with some of the tertiary quadrupeds once denizens of the same regions, or regions formerly connected by land," or where, "without this close affinity, a considerable resemblance is found between special tribes now living and others fossil in the same region," as in a part of America "among the Edentata, which though not quite confined to that region, are more plentiful there than elsewhere, and are successors of fossil races also found almost exclusively in that country;" noting also that the marsupial mammals of Australia had marsupial predecessors, our author continues:—

"The peculiarity indeed is of far earlier origin; for it occurs in the eocene deposits of the basin of Paris, in the lacustrine deposits over the upper oolite at Stonesfield, and probably in the Trias of Wurtemberg. In respect of the Stonesfield fossils, this is not the only evidence presented by that curious deposit of similarity of mezozoic life in the north and cænozoic life in the antipodal region of the south. It extends to other groups, both of the land and sea, and almost justifies the notion of some affinity even in the systems of life. For just as at Stonesfield, so in Australia, small insectivorous marsupial mammals are associated with Cycadaceous plants and Ferns; as now in the seas surrounding Australia, Terebratula and Rhynchonella, Trigonia and Cucullæa, consort with Turtles and the Cestracion Sharks, near reefs of coral, and rivers tenanted by Gavialian Crocodiles, so at Stonesfield in the older time, similar animals in similar combination.

"What does this teach us? Are we looking upon two partially similar, but really separate creations suited to partially similar conditions in very different periods of time? Or is the life-system of the modern Australian land and sea truly derived in some of its components by descent with modification from the older periods of the world, and preserved to this our day, notwithstanding displacement over half the circumference of the globe, and all the vicissitudes of an immensity of time?" (p. 171, 172).

The author proceeds to answer these questions in the following passages in which his volume culminates:

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"Whoever has the courage to adopt the latter view must accept with it the obvious inference, that, in all the countless ages which have rolled away since the branches [?] of Zamia were blown into the lagoon at Stonesfield, the amount of organic change has been small in each group of plants and animals; that a similar amount of change affected the unlike inhabitants of land and sea; that Mollusca and Sharks, and Turtles and Crocodiles, have all been modified by differences of a small description in passing from Oolitic to modern times, while not only hosts of Ammonites and Belemnites have perished in the experiment, but many new forms, as Oliva, Mitra, Triton, Struthiolaria, unknown in the earlier period, have come into view in the latter. But let it be adopted. What follows? These small differences then, accomplished in all that prodigious range of elapsed time, under all that variety of physical changes and removals, these are all the mutations which have been possible under the constant tendency of hereditary descent to perpetuate similar forms with modification.

"One of these genera, that of Trigonia, is known to be in the fossil state rich in species. Supposing them all to have come from one original typical form, the differences which they show in strata of the same system, deposited within the same grand period, and under much similarity of conditions, argue a facility in giving variations: let this operation be supposed to be continued in the interval between the epoch of Stonesfield and that of Australia, and the effects summed by natural selection, the result is the modern *Trigonia*, scarcely differing more in appearance from the fossil species than they differ one from another. But, if not so derived by continual descent, but sprung from separate contemporaneous branches of one stem of life, how should it happen that plants and quadrupeds on land and mollusks in the sea, should in each of these two cases pass with equal advance along the streams of change, moving in one case so fast, in the other so slow? But if the branches sprang at different times and led to these similar results, would this double origin in time, for several similar forms in similar associations, fit with the hypothesis of continual development?"

This is neatly put. But it seems to be founded on the supposition that variation in descent is somehow *caused* by time and change, and goes on by something like equal increments in equal times; whereas, the cause of variation is wholly occult,—the fact is, that some forms remain long invariable or slightly variable under the same conditions in which others vary freely. If Mr. Darwin's theory is bound to explain variation, or to assign a reason for one species varying when another does not, then it utterly fails, for it can do no such thing. If, however, it does not undertake to account for the diversity of species except by regarding them as varieties of earlier origin and wider divergence,—leaving the reason why the progeny is sometimes unlike the parent in one or more particulars as much unexplained as why it is usually like it, but showing how the struggle for life ensures the extinction of crowds of intermediate forms, and now the resulting natural selection may lead certain surviving races farther along the lines of favorable variation,—then it avoids the force of many of the criticisms which have been directed against it.

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The criticisms from which, however, it is least able to escape are those which call for lacking intermediate forms between tribes, families, and other great groups, or for some evidence that they ever existed. Here Prof. Phillips as a geologist feels his advantage and urges his point more aptly than some other critics have done.

"The explanation offered in the hypothesis of Mr. Darwin is, that the groups of life which appear to be and really are distinct, in the Cambro-Silurian rocks are not aboriginal forms, but derived from progenitors of far earlier date, belonging to few types or to one, the original form, and the transition forms being known to us. Now they are not unknown to us by any impossibility of being preserved, for the strata of the Cambro-Silurian series are of a kind in which organic remains of great delicacy are often preserved, and indeed such are preserved in these very strata; and by the hypothesis the life-structures which are lost must have only gradually differed in their nature from those which are preserved. It follows, therefore, that the earlier-living progenitors of the Cambro-Silurian series not only lived long before, but must have lived somewhere else. But as in all the known examples of this series of strata, wherever found, we have everywhere animals of the same general type, and nowhere the traces of the earlier progenitors, it is clear that everywhere we are required by the hypothesis to look somewhere else;—which may fairly be interpreted to signify that the hypothesis everywhere fails in the first and most important step. How is it conceivable that the second stage should be everywhere preserved, but the first nowhere?" (p. 214, 215.)

So, also, of what follows:

"Are we sure that varieties which are given by nature in successive generations can be *summed up in one direction* by the variable preponderant of a number of *concomitant variable conditions* of life? Can we remove 'natural selection' from the large synonomy of 'chance' except by giving to one of the variable conditions of which it is the sum, direction, definite value, or effect. Is it not the one acknowledged possession of every species, an inherent tendency to propagate its like? Would not the effect of this one constant among any number of variables without law be to preserve the characters of the species forever?" But what, we ask, is this inherent tendency of the species to propagate its like but the summing up in one direction of the tendency of each generation of individuals to propagate its like? Is not the occasional appearance of an offspring unlike the progenitor as much a natural fact as the contrary? And does not each initial variety, once originated, also have an inherent tendency to propagate its particular like, which, when it prevails for some generations, fixes a new "constant" which would equally tend "to preserve the characters of the 'variety' forever?"

"And," continues our author, "if 'natural selection' were regarded as giving direction to these variables, in combination with that constant tendency, what would be the final result but that which has always been recognized, viz: a species varying within limits which are to be sought out by experience. But finally, if natural selection be thus gifted with the power of continually acting for the good of its subject, encouraging it, or rather compelling it to continual advancement,—how is this beneficient personification to be separated from an ever-watchful providence,—

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which once brought into view sheds a new light over the whole picture of causes and effects?" (p. 215, 216).

We answer, nohow, except by indicating to some extent the mode or way in which this Providence may operate.

The more we can recognize or clearly conceive the mode, the better; but, whether we can express the results of observation in the form of general laws or not, we are equally convinced that "what would be regarded as remarkable inventions if they were due to human minds and hands," "cannot be removed from the list of intelligent adaptations because they are frequent in nature, and are of higher perfection and greater beauty than any work of man;" and that "no one will ever be [or rather, reasonably can be] satisfied with laws which had no Author, works which had no Maker, co-ordinations which had no Designer."

And our author does simple justice to Lamarck in giving him the benefit of his own averment that "by Nature we are to understand a certain order of causes and effects constituted by the will of the Supreme Author of all things." The points against Darwin's theory made or suggested in the present volume, with so much acuteness, are all the more telling for the entire fairness and excellent spirit in which they are made. This is far more than can be said of the following essay, viz:

3. *Species not Transmutable nor the Result of Secondary Causes; being a Critical Examination of Mr. Darwin's Work*, &c; by C. R. Bree, Esq., M.D., F.L.S., &c.—London, Groombridge & Sons.—A favorable notice in the Athenæum of Dr. Bree's volume led us to suppose that it might be a contribution of some importance in the discussion of the nice questions which the publication of Mr. Darwin's book has raised. But this expectation has not been fulfilled on perusal. The author's intentions are praiseworthy, and his zeal in a good cause exuberant. But we cannot entertain a great respect for the reasoning of a writer who, on the one hand sees design and adaptation in the distribution of sunshine and rain, and the succession of the seasons, while on the other he insists that *because* "all the parts of a creature act harmoniously and co-ordinately one with another," necessitating the inference "that they were pre-ordained to act collectively for the animal," therefore "they could not have been produced by [through] variation, natural selection, divergence of form," or indeed through any secondary causes whatever. We are unable exactly to comprehend how one who sees design and adaptation realized in the inorganic world through what are called secondary causes, is entitled to declare that the establishment of the doctrine of the succession of species,—each marked with more special if not stronger evidences of design than anything in inorganic nature,—through secondary causes, would "destroy every vestige of a shadow of belief in a watchful Providence and adaptive creation, and strike deeply and irrecoverably at the root both of natural and revealed religion." In our opinion such defenders of the faith play unwittingly into the hands of its most dangerous adversaries. A. G.

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IV. BOOK NOTICES.

1. *The Manufacture of Vinegar: its Theory and Practice, with especial Reference to the Quick Process;* by CHARLES M. WETHERILL, Ph.D., M.D. Philadelphia, Lindsay and Blakiston, 1860. 12mo, pp. 300.—This is a very full, correct, and much needed treatise on an important branch of technology, and the book does credit both to the author and to the publishers. It is well printed and contains but few typographical errors, among which we remark "Bertholet" for "Berthelot," on p. 17, and "Reaumer" in all cases for "Reaumur."

The author professes to have based his work on Otto's "Lehrbuch der Essig Fabrikation," and says in the preface, "The general division of the work, many of the tables, all of the wood cuts, except two, and the quantitative analysis of vinegar, are borrowed from Otto." The first division of the book is devoted to an explanation of the general principles of chemistry, with especial reference to the subject in hand,—to an account of the nature, properties and transformations, of sugar and alcohol, and to a discussion of the various methods of determining the strength of alcoholic liquors and vinegars. The second part gives the practical details of the vinegar manufacture. Scientific accuracy is maintained throughout, and to the trained chemist the book is valuable as giving in one volume all the important matters relating to these various subjects. But though the general principles are clearly stated, it seems doubtful whether a mere practical man could fully comprehend all that is laid down. Yet he could understand enough to prevent him from becoming the dupe of men who make a great secret of the vinegar business and pretend to an exclusive knowledge of valuable receipts or methods. At the present time when scientific schools in various parts of our country, bring instruction within the reach of all who desire it, no one should engage as manager in the manufacture of vinegar, or in any other chemical manufacture, without previous study of chemistry and some training in chemical manipulation. One may learn a great deal from books, if he first learns how to understand books. One may derive much benefit from experienced workmen, if he first acquires a knowledge of natural laws and principles so that he can exercise a just control over the whims and prejudices which such workmen always possess. Like men of other trades, the vinegar maker too often insists on trifling points for which no better reason can be rendered than that such has been his beaten track; to such the work now under consideration will prove very useful, as it gives many actual variations in the practical details, thus showing that there are more ways than one of arriving at the same end.

One or two incidental matters occur in the book, to which we must be allowed to take exception. Wood vinegar is spoken of as "pyroxilic acid," and *pyroxylic*,—which is of pure Greek origin,—perhaps it ought to have been called; but the mongrel word *pyroligneous* has been so long exclusively in use that it should pass as the established name. The author also substitutes the term "raisin sugar" for *glucose*, because "*glucose* means *sweet*, and raisin sugar is inferior in sweetness to either

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cane or fruit sugar." It would have been well to consider that *glucose* is derived from the positive γλυκός, and not from the superlative γλύκιστος; and nobody ever thought of calling metamorphosed starch *glucistose*, as the sweetest thing known. The transformations of starch, by the way, recall an undue extension given on p. 66,—and indeed very commonly in books,—to the name "British gum." Practical men—or at least many of them—distinguish roasted wheat starch as *British gum*, while roasted potato starch is called *gum substitute*. And the distinction is said to be founded on a real difference as great as that between the starches themselves.

In speaking of the expression "proof spirits" the author says, "the vinegar maker should be entirely ignorant of proof." But as long as spirits are bought and sold according to 'proof,' neither the buyer nor the seller should be ignorant of what the term means. The common material used in this country for making vinegar by the quick process, is whiskey. The consumer buys it at a specified price for the quantity of *proof spirit* that it contains. He buys say 1000 gallons of rectified whiskey at 25 cts. per gallon, and how much must he pay for it? It is invoiced perhaps as "40 over proof," that is, the 1000 gallons are actually equal to 1400 gallons of *proof spirit;* so the bill amounts to $350. To see whether this charge is correct he should test the liquor by the alcoömeter. One per cent of "dry" (absolute) alcohol is equal to two per cent of proof spirit—that is, New York proof. Hence if the article examined stands at 70° Tralles, it contains 140 per cent of proof spirit, or in commercial language is 40 over proof. So the vinegar maker can no more afford to be "ignorant of proof" than he can ignore the meaning of the term *gallon*.

The subject of acetometry is pretty fully discussed, and by the methods given, one accustomed to nice chemical manipulation will find no difficulty in determining the strength of vinegar. But it is desirable that the common workman should have some simple mode for testing the generators from day to day to see that they turn out a uniform product. There is such a plan in use among calico printers,—a plan which dispenses with exact weighings and measurings and nicely adjusted alcaline liquids, and is therefore deserving of especial mention in any work intended for practical men. Dry slacked lime is added to some of the vinegar to be tested, until there is an excess of lime present, which is known by a sudden change in the color of the solution to yellow or brown and the precipitation of some flocculent matter. The resulting liquid is allowed to settle and is at the same time cooled to 60° F. The hydrometer strength of the clear solution is now noted, and by reference to a table constructed for the particular hydrometer used, the strength in acetic acid will be found with accuracy, enough for all common purposes. Of course this method is applicable only to pure vinegars made from diluted alcohol. Whiskey vinegar is now very largely consumed in calico printing, and for this use it is commonly required to contain five per cent of dry acetic acid. The acetate of lime made from a vinegar of this strength stands at 8° of Twaddle's hydrometer.

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The second part of the work describes several different arrangements of the apparatus for making vinegar as well as various modes of working; and one about to start or remodel a manufactory, would derive much advantage from a careful study of the many plans here detailed. Yet some questions might be asked to which the book gives no satisfactory answer. The first point to be decided is, of what size shall the graduators be made? They commonly have an average diameter of about 3½ feet and a height not exceeding 12 feet. But they seem to be so made rather from precedent than from any actual necessity. It is quite likely that there would be some advantage in having them much wider. As for height, we have no published accounts of any generators higher than 13 feet; and of course the greater the height, the greater is the difficulty of maintaining a sufficient circulation of air through the filling of shavings. Private experience however has shown that twice the ordinary height is none too great. For there are in this country generators in successful operation having a full height of 22 feet. The liquor to be acetified is raised, once for all, and passed through the 20 feet of filling, drawn out at bottom as finished vinegar. These long graduators produce quite as much strong vinegar for the same amount of filling as those of half the height worked in pairs; and being furnished with the feeding apparatus to be described presently, they dispense with a large part of the labor and attention required in the older ways of working.

As to the form of the generators, a word may be said. They are made somewhat conical so that the hoops may be driven tight; but which end should be uppermost? Graduators are always described and depicted as standing on the smaller end. Yet we cannot think of a single advantage in having them so set. It is true the filling usually shrinks more or less in the course of time, and one might suppose that were the taper from the bottom upwards, the filling would draw away from the sides and leave there too free a passage for the air. But it is a somewhat yielding mass we have to deal with. Therefore while it is shortened vertically it presses out laterally. There are on the other hand some slight reasons for departing from the usual custom and adopting the more stable position. The liquor to be acetified is likely to be more uniformly distributed in its passage downwards, if it is showered on the smaller end of a right conical column than when it falls on the larger base of an inverted frustrum. Again the liability to lateral leakage would be much lessened. In the third place some of the hoops require to be renewed while the generators are in operation, and it is easy enough at any time to slip a hoop over a smaller top and drive it down, but to get one up from below is by no means easy. It is particularly difficult to replace the bottom hoop when this has the least diameter of all.

There is much difference of opinion and practice with reference to the admission of air. Some "practical" men insist on boring the holes three or four feet above the false bottom. Others make them an inch or two above. Some lay great stress on bringing in the air by one or more wooden tubes passing up through the bottom of the generator and terminating just below the false bottom on which the filling rests. They forget that air is an elastic fluid and tends to diffuse itself equally

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in every direction so that if it only has a chance to enter anyhow or anywhere below the filling, there is no danger of a partial distribution. There can be no simpler or better plan than to bore two or three holes in the sides just below the sieve bottom. If they are above, there is a chance for the filling to press against the inner orifices and hinder the ingress of air; and to go very high up, is to lose the benefit of all the filling below the holes.

While speaking of air it may not be amiss to mention a very natural mathematical oversight that occurs in Dr. Wetherill's book on p. 259. It is said that:—"Otto discovered by numerous experiments that the air leaving generators in good action, contained from 14 to 16 per cent of oxygen, equivalent to from 4·9 to 6·9 per cent of the oxygen of the air employed in the vinegar fermentation." As in atmospheric air there is 20·9 oxygen to 79·1 nitrogen, an atmosphere that contains 16 per cent of oxygen or 84 per cent of nitrogen, must have had originally with this 84 of nitrogen $\frac{20{\cdot}9}{79{\cdot}1} \times 84 = 22{\cdot}2$ of oxygen. Hence it has lost $\frac{22{\cdot}2-16}{84+22{\cdot}2}$ $=5{\cdot}84$ per cent of the air itself or 27·8 p. c. of its oxygen. And so when an air contains 14 p. c. of oxygen, it has lost 8 p. c. of its first weight or 38·4 p. c. of its oxygen.

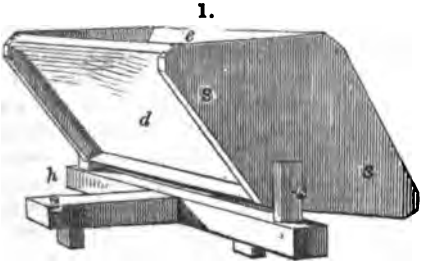
It is said that some manufacturers allow the vinegar to flow out at bottom as fasts as it trickles down, yet we nowhere find a sufficient reason rendered for this plan. Our author after describing a goose neck arrangement, as well as a peculiar cock for drawing the vinegar always from the very bottom of what is constantly accumulating, goes on to say:—"Besides the advantage of saving heat, the vinegar drawn from the bottom of the tub, as by the action of the goose neck or faucet, is of stronger quality, for several reasons which will be given in the proper place." This "proper place," however, is not to be found in the book, and a statement so very questionable is left unsupported by any reasoning. If there are any real advantages in the goose neck or any similar contrivance, it is desirable that they should be specified; for one who has never used such arrangements, can hardly conceive how anything can be, on the whole, better than periodical drawings from a common cock.

The filling is commonly looked upon as merely presenting an extended surface over which the liquor to be acetified flows in a tortuous course from top to bottom. But perhaps the graduator ought rather to be considered as a kind of apparatus for "displacement." It is not improbable that the alcoholic mixtures instead of simply trickling over the shavings saturated with vinegar, partly drives this absorbed vinegar before it, and so a part of the fresh mixture may be several days in reaching the bottom. In fact if we fill a generator with shavings soaked in water and then run on strong vinegar at a moderate rate, we find that it is some time before anything but water flows out from the bottom. This idea of displacement, if correct, ought to be taken into account in theorizing about the process, and it has also some practical bearings. Among other things it should enter into the discussion of the comparative advantages of a constant and a periodical running of the alcoholic mixture. In the case of an interrupted flow, the pores of the filling

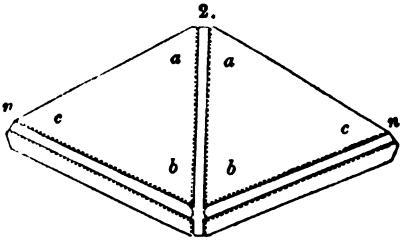
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have a chance each time to empty themselves partially of liquid and become filled with air; and the air will thus be brought into more intimate contact with the liquor of the next pouring. While with a constant flow, the air will be present only in the interstices and not in the pores. Our author very justly considers that pouring at intervals would be preferable to the constant flow, if it could be effected without the great amount of care and manual labor which it commonly requires. He probably is not aware that there has been used in some manufactories in this country, a very simple automatic pouring arrangement which leaves hardly anything to be desired. The principle is that of the oscillator in Gay Lussac's sulphuric acid apparatus. A barrel supported above the graduator, is furnished with a wooden cock which delivers the alcoholic mixture in a very slender stream into a vessel so poised that it shall tip and discharge its contents whenever it has received as much liquor as suffices to cover completely, for a moment, the distributing sieve head. The apparatus used by some consists of a single vessel which rights itself as soon as it has poured out its charge. But as this is made partly of sheet copper, it is liable to obvious objections. The writer has had in operation for more than a year, double oscillators made entirely of wood dove-tailed together. They are easy to construct and very satisfactory in their performance. Each of the compartments holds a wine gallon, which is amply sufficient to cover a sieve head 30 inches in diameter. Fig. 1 is a perspective view of the oscillator mounted on its frame. Fig. 2 shows the inside of the end piece with the dove-tail grooves, *n*, *n*. The whole of the oscillator itself is made of pine boards five-eighths of an inch thick. In the triangles *a b c*, the side *a c* is 7½ inches long, *a b* is 6 inches and *b c* is 7 inches. The sides of the box *d* are 13½ inches long, not including the dove-tail tongues. The middle piece *e* has a shallow, round, or angular groove on each side to receive the lower edges of the side pieces *d*. These side pieces are held fast by the pins *S*, *S*. An indentation on the outside of each end piece receives the sharp point of a brass or iron screw *G*, and on these points the box turns. The right place of the axis is determined by actual trials of the box temporarily poised at different points along the shorter diagonals of the end pieces. After the oscillator is permanently mounted, the tipping may be still farther adjusted by varying the height of the cushions *h* on which the sides *d* drop. The whole apparatus should be well painted before it is set on a sieve head. J. M. O.

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2. *Chambers' Encyclopædia: a Dictionary of Universal Knowledge for the people.* Illustrated with maps and numerous engravings. Large 8vo. Vols. I and II. J. B. Lippincott & Co., Philadelphia. W. & R. CHAMBERS, Edinburgh. 1860.—This excellent Encyclopedia is on the basis of the German *Conversations Lexicon.* It is to be completed in six or seven volumes of about 800 pages each, and fully illustrated with woodcuts in the text and colored maps on steel. Its scientific articles are varied and generally able, covering natural history, physics, astronomy, topography, geography and medicine. The maps are models of clearness and elegance in that style of illustration, which they understand so well in Edinburgh. Messrs. Chambers have earned a well deserved reputation for their efforts to open the treasuries of human knowledge to the people, and in this new enterprize we see the culmination of all former efforts. It will, by the terms of its prospectus, be the cheapest general encyclopedia ever published, as well as one of the most comprehensive. It contains, as is just, few lengthy treatises such as we seek in the Encyclopedia Brittanica and in the American Cyclopedia, thus conforming more strictly to the original idea of an encyclopedia, which was first realized in English by EPHRAIM CHAMBERS in his Universal Dictionary of Knowledge (1728), the basis after the 6th edition, (in 1750) of Dr. Ree's Cyclopedia. We cordially commend the new Chambers' Encyclopedia as worthy of a place in every collection of books for reference.

3. *New American Cyclopedia.* Appletons, N. Y. 1861.—This able and useful work has reached its 11th volume, ending with the word 'Moxa.' It is the plan to close it with the 16th volume. Among the noticeable scientific articles in the 11th volume are '*Microscope*' and '*Mineralogy*,' the first due, as we infer, to Dr. Reuben, and the last to Mr. Hodge, both authors of numerous scientific articles of merit in this Cyclopedia. It is to be regretted that a work in general so excellent should not include in its plan of publication those simple illustrations without which it is hardly possible to make intelligible certain subjects, especially in physics and natural history. During the hours devoted to looking through these volumes, lingering with satisfaction to read not a few of their instructive articles, we have been much impressed with the great amount of discriminating labor and knowledge involved in the management of so great a variety of subjects.

4. *Second Report of a Geological Reconnoissance of the Middle and Southern Counties of Arkansas, made during the years* 1859 *and* 1860, by D. D. OWEN, Principal Geologist, assisted by ROBERT PETER, Chemical Assistant, LEO LESQUEREUX, Botanist, and EDWARD COX, Assistant Geologist. Philadelphia: C. Sherman & Son, Printers. 1860. 8vo, pp. 433.—Having already devoted p. 431–435 to an extended notice of the botanical portion of this Report, we can only add here its title in full. It is beautifully printed, and will be regarded with interest as the last labor of the lamented Owen. The Chemical Report by Dr. Peter contains the results of the analyses of one hundred and eighty-seven soils, subsoils, and underclays, and two nitre earths, besides a variety of other chemical work. The volume is concluded by a brief report by Assistant Cox.

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V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Catalogue of the Meteoric Collection of* CHARLES UPHAM SHEPARD, deposited in the Cabinet of Amherst College, Mass.

METEORIC STONES.

1. 1492, Nov. 7, *Ensisheim*, Alsace, Dép. du Haut-Rhin, France.
2. 1753, July 3, *Tabor* (Plan, Strkow), Bohemia.
3. 1753, Sept. 7, *Liponas*, Dép. de L'Ain, France.
4. 1768, Sept. 13, *Lucé* en Maine, Dép. de la Sarthe, France.
5. 1768, Nov. 20, *Mauerkirchen*, Inn, Lower Austria.
6. 1790, July 24, *Barbotan*, (Roquefort, Créon, Juillac, Mezin, Agen, &c.), Dép. des Landes, Dép. du Gers, Dép. du Lot et Garonne, formerly Gascony, France.
7. 1794, June 16, *Siena*, Tuscany.
8. 1795, Dec. 13, *Wold Cottage*, Yorkshire, England.
9. 1798, March 8–12, *Salès* near Villefranche, Dép. du Rhône, France.
10. 1798, Dec. 13, *Benares* (Krakhut village), Bengal, E. Indies.
11. 1803, April 26, *L'Aigle*, Normandy, Dép. de l'Orne, France.
12. 1803, Oct. 8, *Apt* (Saurette), Dép. de Vaucluse, France.
13. 1805, March 25, *Doroninsk*, Government Irkutsk, Siberia.
14. 1806, March 15, *Alais*, St. Étienne de Solm and Valence, Dép. du Gard, France.
15. 1807, March 13, *Timochin*, Juchnow, Smolensk, Russia.
16. 1807, Dec. 14, *Weston*, Connecticut, U. S. A.
17. 1808, April 19, *Parma* (Casignano, Borgo St. Domino), Italy.
18. 1808, May 22, *Stannern*, Iglau, Moravia.
19. 1808, Sept. 3, *Lissa*, Bunzlau, Bohemia.
20. 1810, Aug. *Tipperary* (Mooresfort), Ireland.
21. 1810, Nov. 22, *Charsonville* near Orleans, Dép. du Loiret, France.
22. 1811, March 12, *Kuleschowka*, Gov. Poltawa, Russia.
23. 1811, July 8, *Berlanguillas*, near Burgos, Upper Castilia, Spain.
24. 1812, April 15, *Erxleben*, between Madgeburg and Helmstaedt, Prussia.
25. 1812, Aug. 5, *Chantonnay*, between Nantes and La Rochelle, Dép. de la Vendée, France.
26. 1813, Sept. 10, *Limerick* (Adare, Scagh, Brasky, Faha), Limerick county, Ireland.
27. 1814, Feb. 3, *Bachmut* (Gov. Iekaterinoslaw), Russia.
28. 1814, Sept. 5, *Agen*, Dép. du Lot and Garonne, France.
29. 1815, Oct. 3, *Chassigny*, near Langres, Dép. de la Haute-Marne, France.
30. 1818, April 10, *Zaborzika* (Saboryzy, Saboritz on the Slutsch,) Volhynia, Russia.
31. 1818, June, *Seres*, Macedonia, Turkey.
32. 1818, Aug. 10, *Slobodka*, Iuchnow, Gov. Smolensk, Russia.
33. 1819, June 13, *Jonzac* (Barbezieux), Dép. de la Charente, France.
34. 1819, Oct. 13, *Politz*, near Gera, Dutchy of Reuss.
35. 1820, July 12, *Lixna* (Liksen), Lasdany, Gov. Witepsk, Russia.
36. 1821, June 15, *Juvenas*, near Libornez, Dép. de l'Ardèche, France.

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37. 1822, Nov. 30, *Futtehpore*, near Allahabad, Hindostan, E. Indies.
38. 1823, Aug. 7, *Nobleborough*, Maine, U. S. A.
39. 1824, Jan. 15, *Renazzo*, Ferrara, Papal States.
40. 1824, Oct. 14, *Zebrak* (Praskolés), near Horzowitz, Beraun, Bohemia.
41. 1825, Government *Iekaterinoslaw*, Russia.
42. 1825, Feb. 10, *Nanjemoy*, Maryland, U. S. A.
43. 1825, Sept. 14, *Honolulu* (Owyhee, Hawaii), Sandwich Islands.
44. 1826 or 1827, *Waterloo*, New York, U. S. A.
45. 1827, May 9, *Nashville*, Tennessee, U. S. A.
46. 1827, Oct. 5, *Bialystok* (Kuasta, or Kuasti village), Russian Poland.
47. 1828, June 4, *Richmond*, Virginia, U. S. A.
48. 1829, May 8, *Forsyth*, Georgia, U. S. A.
49. 1829, Aug. 15, *Deal*, near Long Branch, New Jersey, U. S. A.
50. 1831, Sept. 9, *Wessely* (Dorf Znorow), Moravia.
51. 1833, Nov. 25, *Blansko*, Bruenn, Moravia.
52. 1834, June 12, *Charwallas*, near Hissar, E. Indies.
53. 1836, Nov. 11, *Macao*, Prov. Rio Grande de Norte, Brazil.
54. 1837, Aug. *Esnaude*, Dép. de la Charente, France.
55. 1838, June 6, *Chandakapore*, Berar, E. Indies.
56. 1838, Oct. 13, *Capeland* (Cold Bokkewelde), Cape of Good Hope, Africa.
57. 1839, Feb. 13, *Little Piney*, Pulaski County, Missouri, U. S. A.
58. 1840, July 17, *Cereseto*, near Offiglia, Casale, Piedmont.
59. 1840, *Concord*, New Hampshire, U. S. A.
60. 1841, March 22, *Grüneberg* (Heinrichsau), Prussian Silesia.
61. 1841, June 12, *Château-Renard*, Dép. du Loiret, France.
62. 1842, April 26, *Milena* (Milyan), Pusinsko Selo, Croatia.
63. 1842, June 4, *Aumières*, Canton St. George, France.
64. 1843, March 25, *Biskopsville*, South Carolina, U. S. A.
65. 1843, June 2, *Utrecht*, Blaauw Kapel, Loewenhutye, Netherlands.
66. 1843, Sept. 16, *Klein-Wenden*, near Nordhausen, Prussia.
67. 1844, April 29, *Killeter*, County of Tyrone, Ireland.
68. 1844, Oct. 21, *Favars*, Canton de Laissac, France.
69. 1846 or 1847, *Richland* (near Columbia), So. Carolina, U. S. A.
70. 1846, May 8, *Macerata*, Monte Milan village, Ancona, Papal States.
71. 1847, Feb. 25, *Linn county*, Iowa, U. S. A.
72. 1848, May 20, *Castine*, Maine, U. S. A.
73. 1849, Oct. 31, *Cabarras county*, North Carolina, U. S. A.
74. 1850, Nov. 30, *Shalka* (Sulker, near Bissempur), Bancoora, India.
75. 1851, April 17, *Guetersloh*, Westphalia.
76. 1852, Sept. 4, *Mezö-Maduras* (and Fekete), Transylvania.
77. 1853, March 6, *Segowlee* (Soojoulee), India.
78. 1853, Feb. 10, *Girgenti*, Sicily.
79. 1854, Found. *Pegu*.
80. 1855, May 13, *Bremervoerde*, Landdrostei-Stade, Hanover.
81. 1855, Aug. 5, *Petersburg*, Lincoln county, Tennessee, U. S. A.

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82. 1857, Oct. 10, *Ohaba*, East of Karisburg, Transylvania.
83. 1857, Feb. 27, *Parnallee*, S. Hindostan.
84. 1858, May 19, *Kakova*, Northwest of Oravitza, Temesvar, Banat.
85. 1858, Dec. 9, *Ausson*, (Montrejean), France.
86. 1859, March 26, *Harrison county*, Kentucky, U. S. A.
87. 1859, Aug. 11, *Bethlehem*, near Albany, New York, U. S. A.
88. 1860, May 1, *New Concord*, Muskingum county, Ohio, U. S. A.

Meteoric Irons.

	Dates of Discovery or of Fall.		
1.	Fell	1751, May 26,	*Agram* (Hraschina village), Croatia.
2.	Discov.	1751,	*Steinbach*, between Eibenstock and Joharn-Georgenstadt, Saxony.
3.	"	1768,	*Senegal*, Siratik in Bambuk, Africa.
4.	"	1776,	*Krasnojarsk*, Gov. Jeneseiak, Siberia.
5.	"	1784,	*Toluca*, (Xiquipilco), Mexico.
6.	"	1788,	*Tecuman* (Otumpa), Argentine Republic, S. America.
7.	"	1792,	*Zacatecas*, Mexico.
8.	"	1801.	*Cape of Good Hope*, Africa.
9.	"	1811,	*Elbogen*, Bohemia.
10.	"	1811,	*Durango*, Mexico.
11.	"	1814,	*Bitburg*, Lower Rhine, Prussia.
12.	"	1814,	*Texas* (Red River), U. S. A.
13.	"	1815,	*Lenarto*, Scharosch, Hungary.
14.	"	1816,	*Bahia* (Bemdego), Brazil.
15.	"	1818,	*Lockport*, New York, U. S. A.
16.	"	1819,	*Burlington*, Otsego County, New York, U. S. A.
17.	"	1820,	*Guildford*, North Carolina, U. S. A.
18.	"	1824,	*Rasgata*, New Grenada, S. America.
19.	"	1827,	*Atacama*, Bolivia.
20.	"	1828,	*Caille* (Grasse), Dép Du Var, France.
21.	"	1829,	*Bohumilitz* Prachin, Bohemia.
22.	"	1834,	*Claiborne County*, Alabama, U. S. A.
23.	Fell	1835, July 30,	*Dickson* county, Tennessee, U. S. A.
24.	Discov.	1835,	*Black Mountain*, Buncombe county, North Carolina, U. S. A.
25.	"	1839,	*Asheville*, Buncombe county, North Carolina, U. S. A.
26.	"	1839,	*Putnam* county, Georgia, U. S. A.
27.	"	1840,	*Cocke* county (Cosby-Creek, also Sevier county), Tennessee, U. S. A.
28.	"	1841,	*Newberry* (Ruff's Mountain), South Carolina, U. S. A.
29.	"	1842,	*Green* county (Babb's Mills), Tennessee, U. S. A.
30.	"	1843,	*Oaxca*, Mexico.
31.	Discov.	1843,	*St. Augustine's Bay*, Madagascar.
32.	"	1843,	*Arva* (Szlanicza), Hungary.

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33. Discov. 1845, *Otsego* county, New York, U. S. A.
34. " 1845, *De Kalb* county, Tennessee, U. S. A.
35. " 1846, *Carthage*, Tennessee, U. S. A.
36. " 1847, *Chesterville*, Chester District, South Carolina, U. S. A.
37. Fell 1847, July 14, *Braunau*, (Hauptmannsdorf), Koenigraetz, Bohemia.
38. Discov. 1847, *Seeläsgen*, Newmark, Brandenburg, Prussia.
39. " 1850, *Schwetz*, Province of Prussia.
40. " 1850, *Salt River*, Kentucky, U. S. A.
41. " 1850, *Pittsburg*, Pennsylvania, U. S. A.
42. " 1850, *Seneca Falls*, Cayuga county, New York, U. S. A.

Discovered.
43. 1850–1854, *Lion River*, Namaqua Land, South Africa.
44. " " *Union* county, Georgia, U. S. A.
45. " " *Tazewell*, Claiborne county, Tennesse, U. S. A.
46. " " *Santa Rosa*, New Mexico.
47. " " *Tuczon*, Sonora.
48. " " *Hemalga*, Talcahuaxo, Chili.
49. " " *Haywood* county, North Carolina, U. S. A.
50. " " *Oktibbeha* county, Mississippi.
51. " " *Orange River*, South Africa.
52. 1854, *Madoc*, Canada West.
53. 1856, *Hainholz*, S. W. of Paderborn, Minden, Westphalia.
54. " *Forsyth*, Taney county, Missouri, U. S. A.
55. " *Nebraska Territory*, (between Council Bluffs and Fort Union), on the Missouri River.
56. " *Campbell* county, Tennessee, U. S. A.
57. " *Nelson* county, Kentucky, U. S. A.
58. " *Jewell Hill*, Madison, co., North Carolina, U. S. A.
59. " *Marshall* county, Kentucky, U. S. A.
60. " *Brazos*, Texas, U. S. A.
61. " *Denton* county, Texas, U. S. A.
62. " *Oldham* county, near Lagrange, Kentucky, U. S. A.
63. " *Robertson* county, Tennessee, U. S. A.

Total—88 Stones and 63 Irons, or 151 Meteorites. Their aggregate weight is 820 pounds. The largest stone weighs 51 pounds, and the largest iron mass, 326. The collection contains a large problematical mass from Homony Creek, Buncombe county, North Carolina, supposed to be an altered meteoric iron; also numerous native iron and steel-like masses whose origin is not understood, but which are suspected to be meteoric. To this latter group belong the specimens from Achen, France; Collina de Brianza, Brazil; Walker county, Alabama; Scriba, New York; Randolph county, North Carolina; Bedford county, Pennsylvania; Montgomery, Vermont; Rutherford, North Carolina, and some others. The black capillary matter seen to fall in a glowing state at Charleston, South Carolina, on the evening of Nov. 16, 1857, is also preserved in this collection.

New Haven, Conn., Nov., 1860.

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2. *Note and Correction to Mr. T. Sterry Hunt's paper on Types*, this vol. p. 256–264.—To follow the note on p. 261:—"The formation of a nitrite in the experiments of Cloez appears to be independent of the presence of ammonia, and to require only the elements of air and water (*Comptes Rendus*, lxi, 935). Some experiments now in progress lead me to conclude that the appearance of a nitrite in the various processes for ozone, is due to the power of nascent oxygen to destroy by oxydation the ammonia generated by the action of water on nitrogen, the nitrous nitryl; so that the odor and many of the reactions assigned to ozone or nascent oxygen are really due to the nitrous acid which is set free when nascent oxygen encounters nitrogen and moisture. On the other hand, nascent hydrogen, which readily reduces nitrates and nitrites to ammonia, by destroying the regenerated nitrite of the nitryl, produces ammonia in many cases from atmospheric nitrogen."

Two errors of the press occur in the first seven lines of p. 264—which are corrected in the following paragraph:

"Without counting the still more basic sulphates of zinc and copper, described by Kane and Schindler, we have the following salts, which in accordance with Wurtz's notation, correspond to the annexed radicals:

1. Unibasic, - - - $S_2H\ O_7 = S_2O_5$ monatomic.
2. Bibasic, - - - - $S_2H_2O_8 = S_2O_4$ diatomic.
3. Quadribasic, - - - $S_2H_4O_{10} = S_2O_2$ tetratomic.
4. Sexbasic, - - - - $S_2H_6O_{12} = S_2$ hexatomic.
5. Octobasic, - - - $S_2H_8O_{14} = S_2 - O_2$ octatomic.

3. *Texas Survey.*—We have received the following note from W. M. Gabb on this subject, which we publish without comment.

"I take this opportunity of correcting a statement in your last issue of the Am. Jour. Sci. in regard to my friend Dr. Moore of the Texas Geological Survey. * * * Having been personally cognizant of all the circumstances connected with the change, I feel able to speak confidently of the matter.

"It was determined that when Dr. Shumard's term of appointment should expire (November, 1860) that he should be removed. There were two applicants for the post, and Dr. Moore obtained the use of certain 'influential names' for the purpose of counteracting the weight of a letter written by Humboldt some thirty years ago, in recommendation of the other applicant, and *not* to prejudice Dr. S., whose removal had *nothing* to do with the appointment of any particular successor.

"While I have every confidence in Dr. Shumard's ability as a geologist, I cannot believe that his successor is inferior to him either in erudition, skill or ability. I hope therefore that you will do justice to a gentleman who has been thus unfairly placed before the scientific public.

I remain your ob't serv't, W. M. Gabb."

Philadelphia, March 28, 1861.

4. *Kentucky Geological Reports.*—On page 294 we spoke of the fourth volume of the Kentucky Reports now in press as the 'concluding' volume. As the survey of Kentucky is far from being complete, it is to be hoped that new appropriations of money will enable Dr. Peter and his associates to go on with the work. The chemical part of the fourth volume, covering 390 pages and a vast amount of chemical labor, has just reached us, and will be noticed hereafter.

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OBITUARY.

ERNEST HAEUSSER, an excellent geologist and mining engineer, died in New York on the 18th of February, aged about 35 years. A native of Saxony, educated by the government at the Mining Academy at Freiberg, he came to this country about eight years ago. He was engaged on the Geological Survey of New Jersey, chiefly in the examination of the northern counties of that State, from 1855 to the suspension of the survey. Some of the results of his labors (without his name) have appeared in the Annual Reports of that survey. Frequent exposure to the sickly climate of the Southern States when exploring in North Carolina and elsewhere, broke down his health, developing by intermittent fever the consumption which carried him off. Cautious, truthful, excellent in character, his decease is a great loss to mining enterprises, in which there is always need of the qualities which distinguished Ernest Haeusser.

Botanical Necrology for 1860.—*Professor Hochstetter* of Esslingen, Wirtemburg, died on the 19th of February, at the age of 74 years. The Rev. Prof. Hochstetter produced no important botanical works; but he and his associate Steudel, whom he survived two or three years, were active promoters of botany through the *Unio Itineraria*, an association for furthering botanical collections—of which they were the managers.

Professor J. G. C. Lehmann, of Hamburgh, who died on the 12th of February, in his 68th year, was a botanist of note, and a voluminous author. His earliest work, a monograph of *Primula*, appeared in 1817, his monograph of the *Asperifoliæ* the year after, that of *Potentilla* in 1820. He elaborated the *Onagraceæ* and his favorite genus *Potentilla* for Hooker's Flora of British America; and his latest publication of any magnitude and crowning work was his *Revisio Potentillarum*, a fine quarto volume with 64 plates, issued in the year 1856, an excellent monograph.

G. H. von Schubert, a Bavarian botanist of a former generation, to whom Mirbel in 1813, under the name of *Schubertia*, dedicated the genus established for our southern Cypress, which Richard had earlier called *Taxodium*—survived until July last, having attained the age of 80 years. He is commemorated in an Asclepiadeous genus from Brazil, established by his fellow-countrymen, Martius and Zuccarini.

Dr. J. F. Klotzsch, keeper of the Royal Herbarium at Berlin for the last twenty-five years, died on the 5th of November last at the age of 55 years. As a systematic botanist, Dr. Klotzsch worked industriously, observed discriminatingly, but generalized badly, or rather—like others of the same school—wanted that largeness of view which enables the able naturalist to discover, almost instinctively, the true characters and just subordination of natural groups, in the midst of the most diversified details, and that gift of sound judgment as to natural genera in which Linnæus and the other great masters so much excelled most even of the better botanists of the present age. Dr. Klotzsch's monograph of *Begoniaceæ*, and his papers on *Euphorbiæ* (one of the latter, which dismembers the Linnæan genus *Euphorbia* into more than a dozen genera, published during the past year,) are striking illustrations of the opposite system. The distinctions are doubtless for the most part true and good; their valuation is open to serious objection.

Louis de Vilmorin, of Paris, died on the 22d of March, 1860, at the age of 44 years. Although his name and that of his venerable, still-

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surviving father (to whom DeCandolle dedicated the genus *Vilmorinia*,) hardly appears in the catalogue of botanical authors, yet both have rendered important service to botanical science, while contributing most essentially to the advancement of agriculture and horticulture by original observations, and by experimental researches, devised and conducted upon truly scientific principles, respecting the formation of varieties and their fixation into races, and the amelioration and augmentation of the useful products of cultivated plants. A notice of some of the brief but most suggestive papers of the Vilmorins upon this subject was given in the 27th volume (new series) of this Journal (May, 1829). In devising and conducting such experiments, often requiring both physiological and chemical knowledge, a delicate skill in manipulation, and a quick eye for natural affinities, the younger Vilmorin was unrivalled, and his death in the midst of so useful and so honorable a career, has left a serious void. It is but just to his memory to acknowledge that we have learned more from him respecting the laws and conditions which govern both the production and the preservation of vegetable varieties and races than from any other source. What with his characteristic modesty he entitled an *Essai d'un Catalogue Methodique et Synonymique des Froments*, arranging the sorts of Wheat known in cultivation under fifty-three sections, reduced to seven botanical species, is a work which required the researches of years, although only a pamphlet of fifty pages, and is his most extended publication. His several articles, since collected under the title of *Notice sur l'amélioration des plantes par le semis, et considérations sur l'heredité des vegetaux* are characteristically brief. But they are all the result of the most conscientious, skillful, and prolonged investigations, and all are real contributions to knowledge, the value of which is not to be estimated by the bulk of the record.

J. B. Payer, one of the botanical members of the Academy of Sciences, and Professor of Vegetable Organography and Anatomy of the Faculty of Sciences, at Paris, died on the 5th of September last, aged only 42 years. The correspondence of M. Nicklès has already supplied a biographical notice of Payer, in the preceding (March) number of this Journal. His speciality was organogeny; his principal work *Traité d'Organogénie Comparée de la Fleur*, in imperial octavo, with 154 crowded plates, is a very handsome and imposing production, but perhaps not of the highest critical value. His seat at the Academy of Sciences has recently been filled by another organogenist, of excellent promise, M. Duchartre.

John E. LeConte, former Major of U. S. Topographical Engineers,—whose death, at Philadelphia, in November last, aged 77, was announced in our March No., (p. 303)—was almost the Nestor of American botanists, although his principal contributions to science, except the earlier, relate to zoology, chiefly to entomology and herpetology. His first botanical publication, a Catalogue of the Plants growing spontaneously on the Island of New York, appeared just half a century ago. Many of the choicest botanical stations even seventeen years later, when Dr. Torrey issued his Catalogue of the same district, were as low as Canal St., and Peck's Slip. Even the earlier author lived to see nearly his whole florula extinguished, swept away by denudation, or unconformably overlaid by recent strata of stone, brick and mortar. Major LeConte made exten-

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sive collections in Georgia at a period when that part of the country had been little explored, and freely imparted his materials and his valuable observations to working botanists. He also published several good botanical papers in the earlier volumes of the Annals of the Lyceum of Natural History, New York, and more recently, in the Proceedings of the Academy of Natural Sciences, Philadelphia, an Enumeration of the North American Vines, and a paper on the species of Tobacco, with which, unfortunately, we are not acquainted. For the last ten or twelve years Major LeConte has resided in Philadelphia; and we are to expect from one of his scientific associates there, a fitting tribute to the memory of this venerable, genial, and accomplished gentleman and naturalist.

A. G.

Death of Prof. J. W. Gibbs.—Josiah Willard Gibbs, LL.D., Professor of Sacred Literature in Yale College, died in New Haven, March 25, 1861, aged 70.

He was born in Salem, Mass., April 30, 1790, and graduated at Yale College in 1809. He was Tutor in this institution from 1811 to 1815, and Librarian from 1824 to 1843. From 1826 to the time of his death he was Professor of Sacred Literature in the Theological Department of the College, having been Lecturer here in 1824 and 1825. He was author of a valuable Hebrew Lexicon, and of an abridgment thereof, and of several minor works relating to grammatical and philological subjects, as well as of numerous contributions to the periodical works of his time. The earlier volumes of this Journal contain several important papers from his pen.

He was eminent for careful and thorough research, and all his productions bear marks of exact scholarship. He had been for several years an active member of the American Oriental Society, and of the Connecticut Academy of Arts and Sciences. The last named body, at their meeting of April 17, 1861, passed resolves expressive of their high estimate of the character of the deceased and lamenting his departure.

New Planets.—A new planet, of the 13th magnitude, was discovered April 9, 1861 by Mr. H. P. Tuttle, at the Observatory at Cambridge, Mass. It is probably the 66th of the asteroidal group, the 64th and 65th having been discovered at Marseilles, March 4 and 11, 1861.

New Comet.—A telescopic comet was discovered early in April, in *Draco*, by Mr. Thatcher, at the observatory of Mr. L. M. Rutherford in New York City.

Notice.—*The American Association for the Advancement of Science.*—The Standing Committee have announced that the meeting adjourned to Nashville for 17th April, 1861, will be postponed for one year, to be convened in Nashville, April 1862, unless otherwise ordered in the meantime.

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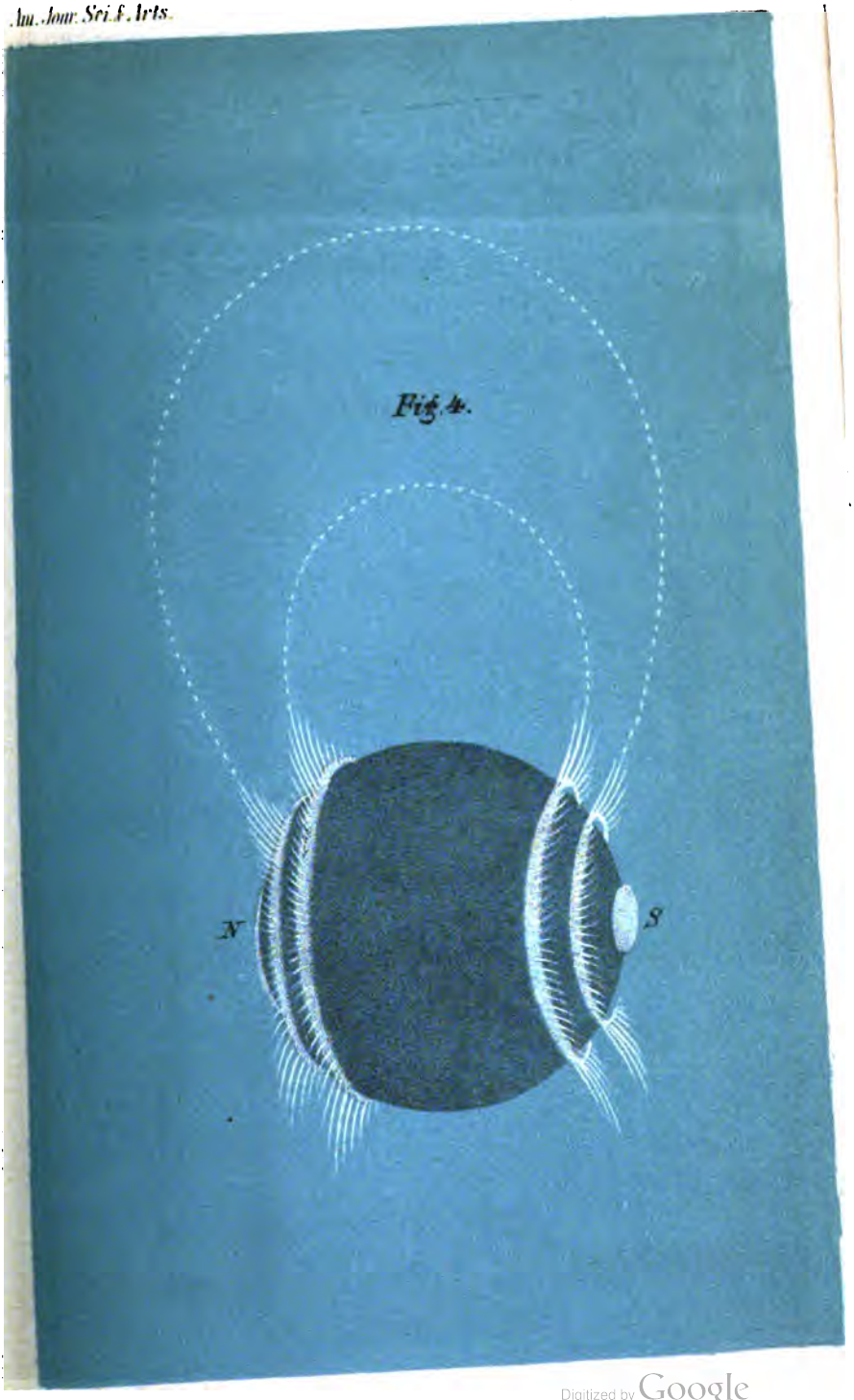
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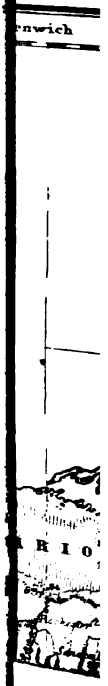


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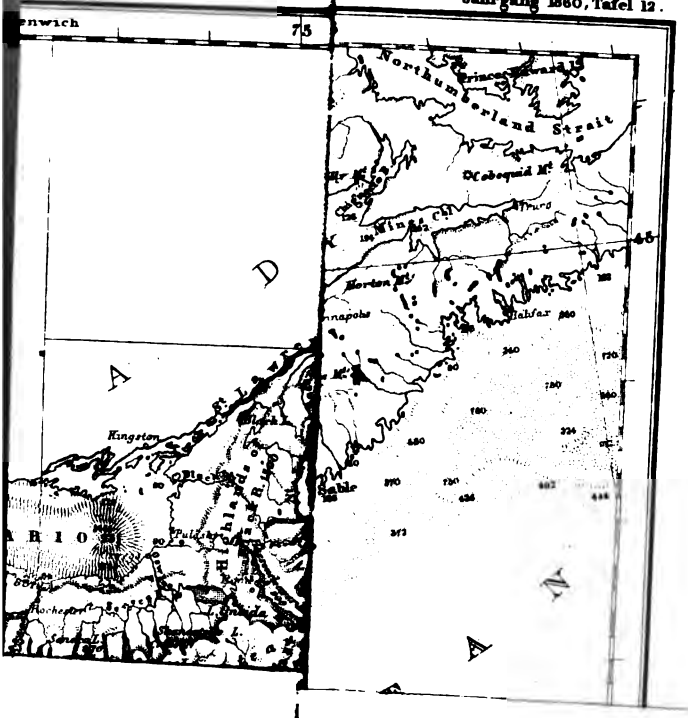
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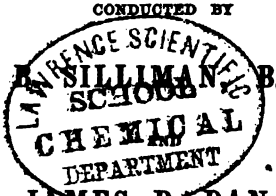
AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,



JAMES D. DANA,

IN CONNECTION WITH

PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK.

SECOND SERIES.

VOL. XXXII.—NOVEMBER, 1861.

NEW HAVEN: EDITORS.
1861.

PRINTED BY E. HAYES, 426 CHAPEL ST.

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ERRATA.

P. 37, 3d line from bottom, *for* "major axis, *read* semi-major axis."
P. 109, 10th line from bottom, *for* "Honzeau," *read* "Houzeau."
P. 416, 17th " " top, *for* "nearly," *read* neatly."
P. 440, top, *for* "Notices of Meteoric Masses," *read* "Notices of Meteors and Meteoric Masses."

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Researches of Pasteur respecting the Theory of Spontaneous Generation;* translated and condensed by M. C. WHITE, M.D.

THE theory of spontaneous generation was long since proposed to account for the origin of beings whose germs were too minute or too obscure to attract attention. One after another the different organisms supposed to arise from spontaneous generation have been proved to originate from germs. At present the question of spontaneous generation concerns only the origin of *entozoa* and those minute organisms which can be studied only with the aid of the microscope, as moulds, (minute fungi), and infusoria both animal and vegetable. The common theory that the spores or germs of these minute organisms are constantly floating in the atmosphere ready to start into activity whenever they meet with a suitable nidus has found an able advocate in M. Pasteur of the Normal School of Paris, who has published in the *Comptes Rendus*,* a series of valuable papers on this subject, the substance of which I have translated for this Journal.

In order to collect and examine the solid particles floating in the atmosphere Pasteur placed soluble gun cotton in a glass tube and by means of an aspirator caused a current of atmospheric air to pass through it for several hours. The cotton was then dissolved in a mixture of alcohol and ether, and the atmospheric dust deposited at the bottom of the fluid in a conical glass was examined with the microscope. The sediment thus collected contained grains of starch and such other dust as is ordinarily found on surfaces exposed to the air. When submitted to the

* *Comptus Rendus*, 1860, T. L, LI.

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action of concentrated sulphuric acid the starch was soon dissolved, while other particles remained undissolved and had all the characteristics of the spores of ordinary mucedines which are known to resist the solvent properties of concentrated sulphuric acid. [It is worthy of notice that certain minute fungi are capable of decomposing a solution of sulphuric acid. A few years since a little mould developed in the solution of sulphate of copper used for electrotyping in the department of the U. S. Coast Survey at Washington proved an intolerable nuisance. It decomposed the salt, assimilating the sulphuric acid and rejecting the copper which was deposited around its threads in a metallic form. From this it appears that sulphuric acid does not prevent but may rather assist the growth of certain fungi.—*Tr.*]

To determine the action of atmospheric air, and of atmospheric dust upon fermentation, putrefaction and the appearance of organization, Pasteur adopted the following methods:

A flask was about half filled with a fluid consisting of water containing in solution about ten per cent of sugar and from two to seven parts in a thousand of the scum of beer. The neck of the flask was drawn out in the flame of a lamp and attached to a platinum tube $\frac{1}{2}\frac{1}{5}$ of an inch in diameter which was then heated to redness. The fluid was boiled for two or three minutes to expel all air from the flask, when it was allowed to cool very gradually, and as it cooled, the air which entered the flask, was calcined and all organic germs it contained were destroyed, by passing through the red-hot platinum tube. When the flask had thus cooled to the temperature of the surrounding air the neck was hermetically sealed. The flask was then removed to an oven and kept at the temperature of 80° or 90° F. for an indefinite period without producing any organisms or undergoing any change whatever.

To test the influence of atmospheric dust upon a fluid thus hermetically sealed, Pasteur placed a pledget of cotton or asbestos in a small tube and caused a current of common air to pass through it by means of an aspirator. This small tube containing the cotton or asbestos loaded with atmospheric dust, was then transferred to a larger T-shaped tube, one end of which was connected by India rubber with the sealed flask, another end was connected with a platinum tube heated to redness, and the third being connected with an aspirator the apparatus was easily charged with calcined air and all the common air was expelled. The neck of the flask was then broken within the T-shaped tube, and the small tube containing the atmospheric dust was passed into the flask with access only of calcined air. The neck of the flask was then again hermetically sealed by means of the blowpipe. Many flasks were prepared in this way and in every case after standing in a warm situation for 24 to 36 hours, vegetation

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appeared in the same manner as if the contents of the flask were exposed to the open air; but the mould or mucedines appeared first in the little tube carrying the cotton which was often thus filled to its extremities. The organic growths which appeared, were the same as in flasks exposed to the open air, viz: of infusoria, *bacterium*, of mucedines the *penicilium*, *ascophora*, *aspergillus* and some others. When calcined asbestos alone was introduced no vegetation appeared.

It was thus demonstrated that among the dust suspended in ordinary air there are always *organized* corpuscles, and that these powders when mixed with a suitable liquid in an atmosphere of itself inactive, give origin to *Bacteria* and *Mucedines* such as are furnished by the same liquid in the open air.

Pasteur confirmed these results by another method. Similar quantities of the same fermentable liquid were introduced into a series of flasks in all respects alike. The necks of the flasks were all drawn out over the flame of a lamp, and bent into a variety of different forms, but the tubular neck of each flask was left with an opening one twenty-fifth of an inch or more in diameter. In some of the flasks the liquid was boiled for several minutes, but three or four were not heated to the boiling point. All the flasks were then set away in a quiet place free from currents of air. After 24 or 48 hours, according to the temperature, the flasks in which the liquid was not boiled after being put into them, (although all the liquid had been boiled before it was put into the flasks), were found to be troubled and covered little by little with mucor. The liquid which had been boiled in the flasks remained limpid not only for days, but even for entire months, although all the flasks were left open. There can be no doubt that the curves and sinuous forms of the necks, served to secure the contained fluid from the fall of germs.

The common air entered these flasks as they were cooling, but so slowly during the gradual cooling of the hot liquid, that the germs were either destroyed by the heat, or were deposited in the curvatures of the narrow necks of the flasks so that no viable germs reached the liquid. When the neck of one of these flasks was broken off, and the remaining portion placed vertical, in a day or two the liquid became mouldy or filled with bacteria. This method which so well explains the preceding, and which can be so readily practiced by any one, carries conviction to unprejudical minds. It gives also peculiar interest to the proof which it presents to us that *there is nothing in the air except its dust which is a condition of organization.* It thus appears that oxygen acts only to sustain life furnished by germs, while of gas, fluids, electricity, magnetism, ozone, things known or unknown, *there is nothing in the air except the germs which it carries which can originate organic life.*

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Fermentation of Urine.—A flask with an attenuated neck was one-third filled with fresh urine and boiled for three or four minutes and then allowed to cool with no access of air except what was drawn through a platinum tube heated to redness. When cool the flask was hermetically sealed and the enclosed urine was thus exposed only to atmospheric air deprived by heat of all viable germs. In this condition the urine remained for months without change. Into a flask thus prepared, asbestos charged with atmospheric dust was introduced by the method above described. The flask was kept at 86° F., and in about six hours mucedines and infusoria appeared, among which were *Bacteria*, *Vibriones* and *Monads*, the same as appeared in similar urine exposed to the open air. During the following days lithates and crystals of triple phosphate were deposited, the urine became ammoniacal and its urea disappeared under the influence of the true ferment of the urine, which Pasteur believes to be organized, and whose germ, could only have been introduced in the atmospheric dust in connection with the germs of infusoria and mucedines. When a flask prepared in the same manner had only calcined asbestos introduced, without atmospheric dust, neither mucedines nor infusoria appeared, neither did any fermentation take place however long the flask was permitted to remain unopened.

Coagulation of milk.—Fresh milk was boiled in a flask for two or three minutes only, and after being allowed to cool with access of calcined air, as in the preceding experiments, it was hermetically sealed. In eight or ten days the milk was coagulated, but when opened it was found remarkably different from milk coagulated in the open air for it remained *alkaline as fresh milk;* but the milk was filled with infusoria, most frequently *vibrios* about $\frac{1}{1000}$ of an inch in length, yet no vegetable productions were detected.

The common theory that milk coagulates in consequence of the formation of lactic acid is an error. It is also shown that vibrios may appear in milk which has undergone ebullition for several minutes at 212° F., although urine or a solution of sugar and albumen does not produce vibrios under such conditions. In other experiments the milk was boiled for longer periods under a pressure of $1\frac{1}{2}$ atmospheres at a temperature of 230° or 235° F., and the flasks were sealed as before. Flasks thus prepared furnished no infusoria, the milk did not coagulate however long it remained enclosed in the flasks, it remained alkaline even with the presence of oxygen in the form of calcined air as stated above, and it preserved apparently all the properties of fresh milk.

Into flasks of milk thus prepared Pasteur introduced atmospheric dust by the method detailed above, when the milk coagu-

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lated and both animal and vegetable productions appeared as in the milk exposed to the open air. The generally admitted theory of ferments which had of late years received fresh support from the writings of chemists, now appears more and more at variance with the results of experiments. The ferment is not a dead substance without determinate specific properties. It is a being whose germ is derived from the air. It is not an albuminous substance altered by oxygen. The presence of albuminous matters is an indispensable condition of all fermentation because the "*ferment*" depends upon them for its life. They are indispensable in the light of an aliment to the ferment. The contact of the atmospheric air is, primarily, equally an indispensable condition of fermentation, but it is indispensable only as being a vehicle for the "*germs*" of the "*ferments.*"

There are many distinct organized ferments which excite chemical transformations, varying according to the nature and organization of the ferment.

To confute various objections made by advocates of spontaneous generation, Pasteur undertook to determine the relative abundance of organic germs in different localities. A series of flasks were all one-third filled with the same putrescible fluid (a solution of sugar and albumen was employed in most of the experiments). The fluid was then boiled for 2 or 3 minutes in the flasks and the neck of each flask was drawn out to a fine point and hermetically sealed while the fluid was hot. These flasks were then taken to different localities and the points of the necks were broken and the air of the several localities allowed to rush in and fill the flasks. This violent ingress of air carried in of course all the dust held in suspension and all other principles known or unknown associated with it. In this condition each flask was again hermetically sealed and the whole placed where they were kept at a uniform temperature of 80° to 85° F., a temperature known to be the most favorable for the development of animalcules and mucors. The results of these experiments were not what the principles generally admitted would lead us to expect but they were perfectly consistent with the theory of the diffusion of germs.

Generally in 3 or 4 days the liquid in the flasks was found altered, but in flasks placed in identical conditions were found very different organisms—much more varied so far as mucedines and torulas were concerned than if the liquids had been freely exposed to ordinary air. On the other hand it frequently happened in a series of experiments that several of the flasks remained absolutely unaffected for an indefinite time as if it had received only calcined air.

This simple and unobjectionable method of experimenting appears to demonstrate that the cause of so-called spontaneous

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generation does not exist in the ambient air throughout its whole extent, but that it is possible to take up in a single place and at a given instant a considerable volume of ordinary air which, without having undergone any physical or chemical change, is altogether unsuitable to give origin to infusoria or mucedines in a liquid which is invariably thus altered when it is exposed to the open air. The partial success of these experiments shows that by these movements of the atmosphere there is always brought to the surface of a putrescible liquid in an open vessel a quantity of air sufficient to furnish germs suitable to be developed in two or three days.

It appears that the organic productions in the flasks are more various than if the contact with the air had been free, i. e., the organisms in the several flasks are different. This result might have been expected, for by limiting the rush of air and repeating it with different flasks, a small number of germs would be collected in a limited portion of air and the growth of these germs would not be obstructed by other germs, more numerous or more vigorous or rapid in their growth, capable of monopolizing the soil to the exclusion of those less vigorous or less rapid in growth.

It was found that the number of negative results varied greatly with the atmospheric conditions, and that nothing was easier than to increase or diminish the relative proportion of flasks which gave birth to the organisms mentioned, or the number in which they were totally absent.

In the cellars of the observatory at Paris, so situated as to have very little change of temperature, and where the air was remarkably quiet, the proportionate number of flasks that were opened in that locality without producing any organisms was much greater than for the same number of flasks opened in the court-yard of the Observatory where the air was constantly agitated.

The explanation of this difference is obvious. Although the air of the cellars of the Observatory, nearly saturated with moisture, was more fitted for the production of the various kinds of mould and infusoria than the open air of the court-yard, yet the stillness of the air in the cellars allowed all ova and spores to be deposited by the force of gravity, and few or none remained floating in the air which rushed into the flasks opened in that locality. In proportion as more precautions were taken to avoid agitation of the air there was less appearance of organization, and Pasteur concludes that if the flasks could be opened and closed in the cellars without the disturbance of the air caused by the entrance of the operator there would be the same absence of vitality in the flasks filled with air from that locality as if they were filled with air exposed to a red heat.

The following results were obtained by Pasteur with flasks opened in widely different localities:

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Sixty-three flasks were each one-third filled with a clear liquid obtained by filtering water mingled with the scum of beer, all solid matter being removed by the process of filtering. This liquid is known to be very susceptible of change, for exposure to ordinary air for two or three days is sufficient to give birth to small infusoria or a variety of mucedines. The fluid was boiled in all the flasks and they were hermetically sealed as in the previous experiments. Twenty of the flasks thus prepared were opened and closed in the country far from any habitation, at the foot of those heights which form the first plateau of of the Jura mountains.

Twenty other flasks were filled with air upon one of the mountains of the Jura 850 metres (2789 ft.) above the level of the sea. Another series of twenty flasks were carried to Montanvert near the Mer de Glace to an elevation of 2000 metres (6562 ft.) where they were filled with air and hermetically sealed like the others.

Of the twenty flasks opened in the level country six developed organic productions. Among the twenty flasks opened upon the plateau of the Jura, only five developed organisms. But of the twenty flasks filled with air at Montanvert, when a strong wind was blowing from the gorges of the Glacier des Bois, one only produced organisms.

These experiments show that the air from elevated localities is remarkably free from those germs which give origin to organic products.

In collecting air for these experiments the following precautions were adopted to avoid as far as possible the intervention of dust carried by the operator or deposited on the outside of the flask or other implements required in performing the experiments. The elongated neck of the flask was first heated in the flame of a lamp and a scratch was made upon the glass with a file. The flask was then raised above the head with the end of the neck turned toward the wind and the point was broken off with long iron forceps, the branches of which had previously passed through flame to destroy any dust adhering to their surface so that it might not remain to be driven into the flask by the sudden rush of air when the point of the flask was broken. Great pains were taken lest the agitation of the liquid in the flasks during transit might exert some influence unfavorable to the development of infusoria or mucedines.

The following results are therefore without objection and they show the entire difference between the air of the plain or of elevations and that of inhabited places. Pasteur's first experiment at the Glacier des Bois was interrupted by a circumstance which had not been foreseen. He had taken to close the points of the flasks, after they were filled with air, an eolipile lamp fed with

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alcohol. The whiteness and glare of the ice, in the light of the sun, was so great that it was impossible to see the jet of alcohol flame, and as it was agitated by the wind it could not be directed upon the glass with sufficient steadiness to melt the point and hermetically seal the flask. As no means were at hand to render the flame visible, the flask could not be sealed, and there remained chances of error by the admixture of other powders. The three flasks which had been opened were therefore taken to the small village of Montanvert and sealed at his lodgings the next morning, after they had been exposed all night to the dust of the chambers where he slept. Of these three flasks only two produced either infusoria or mould. Since the number of flasks altered in this experiment is greater than that in those which followed, (the twenty flasks previously noticed), Pasteur concludes that the agitation of the liquid during the journey had no influence upon the development of germs.

It therefore appears to be satisfactorily demonstrated:

1. That the air of inhabited places contains a greater relative number of fruitful germs than the air of uninhabited regions.

2. That the ordinary air contains only here and there, without any continuity, the condition of the first existence of generations sometimes considered spontaneous. Here, there are germs and there, there are none.

3. There are few or many, according to the localities. Rain diminishes the number but after a succession of fine days they are more numerous. Where the atmosphere has been for a long time quiet germs are wanting and putrefaction does not take place as in ordinary circumstances.

Gay Lussac, Schwann and Pouchet have performed various experiments upon liquids in contact with common air, with heated air, with artificial air, and with oxygen gas, using a mercurial bath to isolate the substances experimented upon. Some of their results have appeared to favor the theory of spontaneous generation. Pasteur has ascertained that mercury taken from the bath in any laboratory is itself loaded with organic germs. He took a globule of mercury surrounded by an atmosphere of calcined air and passed it into a flask of putrescible fluid by the process detailed in the former part of this paper. In every experiment of this kind after two days an abundant growth of organic products appeared.

The same experiments were repeated with the same liquids, with no change of manipulation, with the same kind of mercury, except that the mercury was first heated to destroy the germs it contained, and no growths whatever appeared in the flasks.

From all these experiments Pasteur concludes that: *Powders* suspended in the air are the exclusive origin, the first and nec-

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essary condition of life in infusions in putrescible bodies and in liquids capable of undergoing fermentation. It is easy to collect and observe with the microscope atmospheric dust, among which may always be found a great number of organized corpuscles which the experienced naturalist will distinguish as the germs of inferior organisms.

[Some infusoria are not more than $\frac{1}{12000}$ of an inch in diameter and if we suppose that the ova of infusoria and the spores of minute fungi are no more than one-tenth part the linear dimensions of the parent organism there must be an incalculable amount of germs no larger than $\frac{1}{120000}$ or $\frac{1}{1200000}$ of an inch in diameter. Since according to Sullivant and Wormley, (This Journal, vol. xxxi, p. 12,) vision, with the most powerful microscope, is limited to objects of about $\frac{1}{75000}$ of an inch, we need not be surprised if infusoria and other organisms appear in putrescible liquids in far greater numbers than the germs in atmospheric dust visible by the aid of the microscope would lead us to expect.—Tr.]

Pasteur proposes to continue these investigations and expresses the hope that the way may thus be opened for a successful investigation of the origin of different diseases.

New Haven, May 1, 1861.

Art. II.—*Natro-boro-calcite and another Borate occurring in the Gypsum of Nova Scotia;* by Henry How, Professor of Chemistry and Nat. Hist., King's College, Windsor, Nova Scotia.

About three years and a half ago I showed the existence of Natro-boro-calcite in the Gypsum of Windsor N. S.* I was not aware at that time that Dr. Hayes of Boston, U. S. had announced his conviction† that the soda which had been attributed to this mineral was an impurity and had given as the true expression of the composition of the pure mineral the formula $CaO\ 2BO_3+6HO$. Had I known this I should have adverted to the probability of his mineral, (Hayesine, *Dana*) constituting a distinct species from Natro-boro-calcite whose existence seems to be sufficiently established by the repeated finding of not very dissimilar quantities of soda in analyses of specimens from two of its three localities, as seen in the following list which contains all the analyses I have been able to find:

* Edin. N. P. Journal, July, 1857. This Journal, Sept. 1857.

† This Journal, Nov., 1854, p. 95.

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	BO_3	CaO	HO	NaO	KO	SO_3	NaCl	Sand	
Peru,	46·11	18·89	35·00						Hayes.[a]
Tuscany,	51·13	20·85	26·25						Bechi.[a]
Peru,	49·50	15·90	25·80	8·8					Ulex.[b]
Peru,	49·50	17·70	26·00	8·8					" [b]
Peru,	45·46	14·32		8·22	0·51	1·10	2·65	0·32	Dick.[a]
Peru,	43·70	13·11	35·67	6·67	0·83				Ramm.[c]
Peru,	47·25	15·98	25·46	9·88		0·45		0·98	Anderson[d]
Nova Scotia	41·97	13·95	34·39	8·36		1·29	MgO	0·04	H. How*
" "	44·10	14·20	34·49	7·21					"

(*a*) Dana's Min., 4th Ed., p. 394. (*b*) Liebig und Kopp's Jahrb. 1849, p. 780. (*c*) this Jour., Sept., 1857, Third Supp. to Dana's Min., p. 6. (*d*) Proc. Phil. Soc., Glasgow, Feb., 1853.

In the account of the analysis by Anderson the quantities of soda and SO_3 as above given are reversed, but from the conclusion drawn by the author this is evidently a mistake. As regards the amount of water present, no mention is made in any case but my own as to the temperature at which the substance was dried; in my analyses the mineral was air-dried. The soda, it will be observed, is a constant ingredient in pretty uniform amount in all but the first two analyses, and in my examination, as stated at the time, the mineral was washed for the second analysis with cold water till all sulphuric acid was removed.

From the preceding data the following formulas have been deduced:

$CaO\ 2BO_3+6HO$	Hayes,
$NaO\ 2BO_3+2CaO,\ 3BO_3+10HO$	Ulex,
$NaO\ 2BO_3+2CaO,\ 3BO_3+15HO$	H. How,
$NaO\ 2BO_3+2(CaO\ 2BO_3)+18HO$	Rammelsberg,

all referring to a mineral found in rounded masses, consisting of interwoven fibres, opaque, snow-white and of a silky lustre.

The mineral to which I would now draw attention was found in the same quarry as the preceding, at a distance of about 100 yards and at about 20 feet lower level, and also associated with Glauber-salt, which, it is worthy of notice is generally met with here, according to the quarrymen, in narrow seams at the line of junction of the "hard plaster," (Anhydrite) with the "soft plaster," (Gypsum). I detected it in the form of an opaque white substance without lustre, and, to the naked eye, devoid of crystalline structure, in cakes and somewhat rounded masses varying in size from that of a small pea to that of a bean; these masses lay between gypsum and crystals of Glauber-salt, taking shape from the crystals of the latter on the side next to them, and when detached from them leaving their faces, as it were, etched, and sometimes the crystals were penetrated to a considerable depth by the imbedded borate. The mineral is very soft, (H.=1) but coherent, tasteless, slightly tough between the teeth, fuses readily B.B. to a clear bead, insoluble in water, soluble in HCl. As found, or very soon after being brought home, it lost by exposure to air, Water=18·36 per cent,

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and the air dry substances gave the following results on analysis; the water was determined by ignition, the lime, magnesia and sulphuric acid in one portion of the ignited residue, and the soda in another, after its treatment with fluor-spar and sulphuric acid for separation of boracic acid, which was, of course, estimated by deficiency:

	I.	II.
Lime	14·21	——
Soda	7·25	——
Sulphuric acid	3·98	——
Magnesia	0·62	——
Water	19·96	20·78
Boracic acid	53·98	——
	100·00	

The quantity of mineral obtained did not permit me to make more than one analysis and retain a little as a specimen for identification, but these results as well as the characters already mentioned and the crystalline structure to which I shall presently advert, are, I think, sufficient to show that it is specifically distinct from Natro-boro-calcite (see analyses quoted). On the assumption that the magnesia and sulphuric acid are accidental, and that the latter is combined with the former and with a quantity of soda equivalent to that of the acid not required by the magnesia, I have calculated the preceding results (I) after making these deductions, and at the same time taking away the amount of water necessary to render the $MgOSO_3 = MgOSO_3 + 7$ aq.; (the hydrated sulphate of soda would of course become anhydrous on exposure to dry air); the results then become:

		Oxygen.	Ratio.	Calculation.		
Lime,	15·55	= 4·44	3·08	3CaO	84	15·64
Soda,	5·61	= 1·44	1·00	NaO	31	5·77
Water,	19·72	=17·52	12·16	12HO	108	20·11
Boracic acid,	59·10	=40·47	28·10	$9BO_3$	314·1	58·48
	99·98				537·1	100·00

corresponding to the formula,

$$NaO, 3CaO, 9BO_3 + 12HO$$

I am very well aware that it is unsafe to base a formula upon a single analysis, especially of a mineral substance, and most especially after making deductions as above, and I cannot in this case insist on the one brought out, but it is not anomalous. We find rather complex combinations both in the natural and artificially formed compounds of boracic acid, thus:

Hydroboracite,* $= 3CaO, 4BO_3 + 3MgO, 4BO_3 + 18HO$, and
Larderellite,* $= NH_4O, 4BO_3 + 4HO$.

* See Dana's Min. 4th Ed., pp. 394, 395.

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while Laurent* describes a salt $=5NaO, 24BO_3+52HO$, and Rose† one $=3CaO, 5BO_3$ when ignited, and it is a little curious that the formula given above includes the soda salt corresponding to Larderellite and the salt of Rose.

$$NaO, 4BO_3+3CaO, 5BO_3+12aq.$$

I mentioned that the mineral presented no appearance of crystalline structure to the naked eye; not having at hand, at the time I was at work upon it, a sufficiently good microscope, I sent a portion of the mineral to Professor Robb, of the University of New Brunswick, at Frederickton, with a letter stating my results and my doubt as to the substance having crystalline structure; I received this answer; "In spite of your odd formula, the mineral, just as I got it, untouched and unwashed, is perfectly crystalline in every particle. A good power is required, but with a magnifying power of about 350 diameters there is no difficulty, the form comes out as sharp as possible. The crystals are excessively thin translucent tables or plates. They have a rhombic outline and the angles probably $=80°$ or more, owing to their excessive thinness I could not say whether they could be called right or oblique rhombic prisms. I suspect the latter from analogy. By care the 'Tiza' (Natro-boro-calcite) can be shown to consist of very fine prisms, sharp, angular and long, but too fine for me to state their form. The diameter was less than ·00118 of an English inch. The long prismatic needles of the Tiza are in great contrast to the broad tables of the recent mineral in your last letter; of that the plates are about ·0048 of an inch from side to side, but some are a little larger, others a little smaller. In some you see regular cleavage, that is, a small rhomb chipped out of one side. As far as form goes therefore it would seem to be a distict and definite species. I presume it was formed in a dry place for the angles were quite sharp. The connection between these borates and sulphates of lime and sulphate of soda is very curious."

I may state that I had subsequently the opportunity of appreciating the great accuracy of this description of the appearance of the two minerals.

Arguing from the chemical composition, which however may not be quite established, and the crystalline structure, I conceive the mineral in question to constitute a new species, and I propose for it the name of Cryptomorphite (κρυπτος, occultus, μορφη, forma) in allusion to its microscopic crystalline structure.

The truth of the last sentence in Prof. Robb's letter is very apparent. In my former paper on the subject I adverted to the existence of Natro-boro-calcite in the Gypsum here as confirming

* Liebig und Kopp's Jahresbericht, 1849, p. 226.
† Liebig und Kopp's Jahrb., 1852, p. 313.

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Dawson's theory of the origin of the rock from volcanic waters acting on the carbonate of lime; it is interesting to observe that Bechi found* the same mineral, with other borates, in the lagoons of Tuscany. The hydrated conditions of both the borates found in the rock here and of the associated Glauber salt shows the action of water, but that of ordinary sea-water would not acconnt for the presence of boracic acid. As regards the soda, the sulphate and borate of lime were probably the substances originally present, and chlorid of sodium in water being introduced might remove part of the calcium as chlorid, and furnish borate and sulphate of soda; it is confirmatory of this view that a small quantity of rock-salt in crystalline grains has lately been found in the Gypsum.

ART. III.—*On Gyrolite occurring with Calcite in Apophyllite in the Trap of the Bay of Fundy;* by HENRY HOW, Professor of Chemistry and Nat. Hist. King's College, Windsor, Nova Scotia.

THE Mineral Gyrolite was first described by Professor Anderson of Glasgow,† as a new species from the Isle of Skye; it is stated by Greg and Lettsum‡ to occur without doubt at two localities in Greenland, and, according to Heddle, at Faröe. The only other notice of it that I am acquainted with is by L. Sæmann, who§ mentions that he examined a specimen, no locality being given, mixed or interlaminated with pectolite, and suggests that this mineral losing its alkali becomes gyrolite, and losing its lime becomes okenite. No other analysis than the original one of Professor Anderson has, I believe, been published; the following account of its occurrence among the minerals of Nova Scotia, shows it in such association as affords a mode of explaining its origin by change in apophyllite. I met with it in Anapolis County, N. S., some 25 miles S. W. of Cape Blomidon, between Margaretville and Port George, on the surface of fractured crystalline apophyllite, and, on further breaking the mass a good many spherical concretions of pearly lustrous plates were observed in the interior, of sizes varying from that of a pin's head to nearly half-an-inch in diameter; their outline was well defined and the external characters as given by Anderson were recognined on examination; it afforded the following results on analysis. The mineral was ignited for water, and the residue treated with HCl, the resulting dried silica was weighed,

* Dana's Min., 4th Ed., 394, 395.
† Trans. Roy. Soc. Edin. and Phil. Mag., Feb., 1851.
‡ Manual of Min., p. 217.
§ First Supp. to Dana's Min., p. 9. This Jour., May, 1855.

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and then fused with carbonated alkali, and the weight of the small quantities of alumina, etc., so separated, was deducted from that of the first silica. I place my numbers by the side of those of Anderson, and give the calculated percentages for his formula:

	How.	Anderson.	Calculation.		
Potassa,	1·60				
Magnesia	0·08	0·18			
Alumina,	1·27	1·48			
Lime,	29·95	33·24	32·26	$2CaO$	= 56
Silica,	51·90	50·70	52·18	$2SiO_2$	= 90·6
Water,	15·05	14·18	15·55	$3HO$	= 27·0
	99·85	99·78	99·99		173·6

and a general accordance is observed sufficient to show the identity of chemical composition in the minerals examined; the small quantity of potassa present in my specimen probably modified the blowpipe character a little as I found it not to exfoliate completely, and it fused without any difficulty, and even with some ebullition.

Some of the numerous cavities in the apophyllite were empty, some entirely filled with gyrolite, and in others separate plates of this mineral were standing edgewise, leaving vacant spaces, while upon and by the side of the plates were in some cases rhombohedral crystals which proved to consist of calcite and were sometimes present alone in the cavities, which varied from being quite shallow to half an inch in depth. It is mentioned by Anderson that gyrolite occurs associated with stilbite, laumontite and other zeolites, and is sometimes found coating crystals of apophyllite.

The difference in chemical composition between apophyllite and gyrolite is very well seen on comparing the respective theoretical percentages of their constituents, thus:

	SiO_2	CaO	KO	HO
Apophylite,	= 52·70	26·00	4·40	16·70+HF variable.
Gyrolite,	= 52·18	32·26		15·50

and the existence of the calcite in the cavities seems clearly to show that the gyrolite is formed from the apophyllite by the waters which deposited the carbonate of lime reacting on the silicate of potass and dissolving out at the same time the fluorine as fluorid of calcium:* trial was made for fluorine on two fragments of the gyrolite and no evidence of its existence obtained.

* See Dana's Min. I, p. 232–233.

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ART. IV.—*On some questions concerning the Coal formations of the United States;* by LEO LESQUEREUX.—(Continued from vol. xxx, 384.)

General Remarks on the Coal Plants and their Study.

IN the memoirs of the Geological Survey of Great Britain, Dr. Hooker has remarked at length on the difficulties attending the study of the fossil plants of the Coal measures.* I can admit, indeed, with the celebrated English author that this study is far more difficult than could be supposed from an examination of some specimens of fossil ferns, which are found sometimes so handsomely painted upon the shales, that they look as perfect as plants preserved in the herbarium. But I cannot share the whole of his views concerning the insufficiency of the data furnished by palæontological botany and their uncertainty compared with those afforded to Geology by fossil animal remains. Remains of fossil plants are preserved in two ways:

First. We find, especially in the shales overlying coal-banks or occupying their place, the flattened surface, the printed outlines of some peculiar vegetable organs. They are mostly leaflets of ferns, either without traces of fructification, or with the fructification obliterated and dimly visible through the parenchyma of the leaves;† or parts of fronds, broken pinnæ detached from the common rootstock; or pieces of flattened stems without leaves, generally bearing on the surface some peculiar striæ or cicatrices left at the point of attachment of the leaves; or a few isolated and broken fruits, apparently nutlets of unknown relation and structure.

Secondly. We find also fossil botanical remains, either silicified or transformed into coal or mineral charcoal. Silicified wood is common enough in some strata of sandstone intervening between some beds of coal. But it represents parts of stems, or of half decayed trunks, of which the bark has generally been taken off or is entirely obliterated. Such specimens of course expose to the student the internal structure of the wood but nothing else. When the remains of fossil plants are found preserved in coal or charcoal, every trace of a complex organism has disappeared, and nothing can be seen by a microscopical examination but isolated vessels of various forms and size.

We have thus either flattened organs of plants of which we can only see the outline, to which we cannot by any means refer the organs that are essential for determination, like stems, flow-

* It is well to recall the fact that the remarks in this paper regard only the fossil coal plants, though some of them may apply to the fossil flora in general.

† The lower surface of the ferns which bears the fruit, is mostly the one inseparably attached to the stone.

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ers, and fruits, &c., and of which we cannot study the internal structure. Or we have isolated vessels transformed into coal or pieces of silicified wood of which we can study the internal structure only without possibility of comparing it or of referring it to external organs so as to know the outward appearance of the vegetable to which they belong.*

To show at once in its most unfavorable and discouraging aspect the difficulty of studying the botanical palæontology of the coal, we have still to remark that the broken, separated organs of fossil plants, especially the leaflets of the ferns, generally found detached from the stems, are extremely variable. Some perfectly alike in their outline may belong to different species while some others apparently totally different belong to the same plant or even to the same pinna.

As a compensation to these apparently insurmountable obstacles, we have:

1st. The extraordinary simplicity of the flora of the coal and the small number of species that appear to have contributed to its formation. All the leaves found in connection with the coal measures belong to ferns and to a few genera of unknown affinity.

2d. As every botanist well knows, most of the species of ferns have a peculiar and well marked nervation. In the fossil ferns of the coal this nervation is generally well preserved, visible and characteristic enough for the identification of species.†

3d. In some rare cases where the nervation is nearly alike for different species, each of these may be distinguished by peculiar marks, hairs, scales, tubercles or appendages, &c., which permit their identification.

4th. Moreover, one may truly say, that each species even in its most different parts has a peculiar look, easily known at first sight by the palæontologist, though indeed indescribable. And this is true as well for the leaves of the ferns as for the cicatrices which so peculiarly mark the bark of some trunks.

From this it follows, that the characters on which we have to rely for a determination of the fossil plants of the coal are uncertain, indeed, and of little value for an absolute classification or in

* Brongniart, Hooker, Corda, Göppert and a few other palæontologists have had the opportunity of studying through thin, polished sections, the internal structure of a few species of fossil wood, and cones from specimens still preserving the outward form of their bark. They could thus compare the anatomical structure with some external characters. But the pretence of identifying species or even genera from the characters of isolated vessels appears inadmissible, considering the great likeness of these elementary organs in different species and also their variety according to the age of the stem and to their place within it. This question will be examined in detail hereafter.

† Though the number of species of ferns now living is very great, the nervation is still considered by some botanists as sufficiently characteristic to separate the species of a genus and even of subgenera. (See the opinion of Mittenius in this Journal, vol. 31, p. 133).

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comparison with all the species heretofore known, but that they are generally reliable enough for identifying the species of coal plants relatively to each other. This, I think is all that is wanted for an examination of the palæontological botany of the coal. For the flora of the coal-measures constitutes a peculiar group of plants which ought to be studied by itself, whose characters ought to be looked for without any exact relation to plants now living. A certain amount of botanical knowledge, especially of the anatomy and of the geographical distribution of the plants of our epoch, is necessary for that duty; but it can be pursued without the assistance of great and costly botanical cabinets, and even without the acquaintance with a large number of our living plants. Of course the more one knows of botanical science, the more one is prepared to judge of the analogy of the forms of fossil plants or to recall them to an original type. But nobody will attempt the study of fossil plants who has not been prompted by a natural love of the science to devote himself to serious botanical studies.

Comparing now the data furnished by both animal and botanical remains, and considering what is called the insufficiency of botanical palæontology, we have to inquire, first, What results are to be expected from palæontological researches? We reply, nothing less than some more or less precise indications concerning the succession of the beings which have inhabited our globe since the first appearance of life, or a kind of history of the creations or of the modifications of what we may call the *forms of life*. And, as a corollary of the first proposition, some indications of the changes to which the surface of our globe has been subjected, and which, according to the laws governing the forms of life, ought to be attended by the appearance of peculiar beings.

It is indisputable that the external forms of some animals, their shells especially, are generally better preserved in a petrified state than the soft parts of most plants. But animal remains, bones, scales, teeth, are only isolated parts of a whole, and are no better applicable to an exact scientific classification or to a satisfactory identification of a species than a single leaf of a tree. As for the shells, they are simply envelopes, and their affinities to the animal are at best only imperfectly understood. It is true that comparative anatomy has done more for animals than for plants. But the number of leaves is not small of which the outline is so closely related to the form of the whole vegetable that when they are found in a fossil state, they may be immediately and certainly referred to their proper genus. For what concerns families of extinct and unknown forms, I think that the reconstructions offered by comparative anatomy are as reliable for *Lepidodendron*, *Sigillaria*, for whole forests indeed rebuilt from

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pieces of bark or from leaves as they can be for whole fishes, and gigantic animals rebuilt from a scale or a bone.

From another point of view, if it is true that the number of animal fossil remains is far greater than that of fossil plants, it cannot be denied that animal remains are mostly marine and are cast, accordingly, in a scarcely variable general mould. If we should judge of the successive developments of the vegetation of our globe by the fossil marine plants only, we should, indeed, come to a very erroneous conclusion; the *Fucoides*, for example, of all the formations are much alike, and preserve even up to our time their original typical characters.

Marine animal remains appear to have been subjected to appreciable changes only by great geological events, of which natural philosophy cannot thus far fully appreciate the amount of influences. Thus, of course, we have not any solid ground from which to draw reliable conclusions concerning the result of those influences upon the forms of animal life. Botanical palæontology has engraved its records on the rocks, only at very distant epochs, and they present only broken links of a chain, which science may perhaps never be able to connect.

From this it appears that when we come to examine the succession of species from their origin, and search for arguments concerning the problematical question of successive changes or of successive creations, the data now furnished by animal and botanical palæontology respectively, give us about the same amount of light and merit the same reliance.

As indicating the succession of the strata of our globe, or as geological marks, animal remains have this advantage: that as most of the strata have been formed by marine deposition, these remains are more generally found in every part of the geological measures. They are thus an ever present if not always a reliable guide. But the most interesting part of the geological field is entirely barren of those *medals of the creation* to which we look for a record not only of the successive deposition of strata but of all the changes which the surface of our earth has undergone. Marine strata have been formed from materials transported and mostly, at least, taken from dry land. Touching this dry land, the multiplicity of changes to which it has been subjected by that potent and most variable agent, the atmosphere; concerning the various appearances of the successive stories built by the Eternal Power for the ultimate end of the structure, viz:—the habitation of man; about some of the materials prepared and heaped up for his welfare and perfect development; concerning the great harmony of all the beings in the different ages, marine remains cannot give much information. Thus, if the data furnished by one of these special branches of palæontology are more numerous, more universal, more easily found and better preserved and stud-

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ied—those of the other are more precise and so to speak, more applicable to our humanity. Because they speak a human language. They speak of atmospherical changes, of sun and of rain, of seasons and of their variations. They speak of shores battered by the waves and covered with floating debris, of hills, of green fields, of impenetrable forests, of everything that is now in the fullness of its perfection, belonging to the Eden slowly prepared for our abode.

If this does not prove that fossil botany is as useful to science and as interesting as any other branch of palæontology, the few words I have said in its defense will easily be excused: especially as in this country it has had few followers, and is often looked upon with unmerited discredit.

By far the greatest obstacle to the study of the fossil plants of our coal measures is the difficulty of obtaining good specimens, and, when the specimens have been found, of procuring books to make us acquainted with them. We have indeed some few specimens of fossil plants in geological cabinets. But they have been mostly collected by persons unacquainted with fossil botany and are thus incomplete in many ways and of little use for study. Either they want some part essential for a determination, or they have been collected without a close regard to local and stratigraphical position. Fossil botany ought to be studied in the coal mines, among heaps of shales where remains of the same species can be collected in their different forms. Sometimes hundreds of pieces of the shales have to be split before the part of the frond of a fern which may be desired for a satisfactory determination can be found. In many fossil ferns, especially in the *Neuropterideæ*, the terminal leaflet of the pinnæ has a peculiar and characteristic form; and, as the leaflets of this class of ferns are mostly deciduous, these terminal ones are rare and difficult to find. Though whole strata of shales are covered with leaflets of *Neuropteris hirsuta*, and though this species is found at nearly every geological horizon, it is nearly impossible to find the branches with leaves attached to them, and thus to know something of the general appearance of this species.* With the pieces of the bark of some trees, viz. with specimens of *Lepidodendron*, *Sigillaria*, &c., the difficulty of collecting is still greater. For the points or cicatrices left by the leaves, and generally showing in peculiar forms the deposition of the vessels at their point of emerging from the stems, vary in size and distance according to the age of the vegetable or the place on the trunk from which the specimen is taken. Moreover, the cicatrices have various forms following the process of decortication of the

* I have only two small specimens of this species with branches and leaves; one found by myself the other presented to me. Mr. Bunbury saw for the first time such a specimen in the cabinet of Mr. Brown of Nova Scotia.

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vegetable. As it is extremely rare to find in our coal measures a whole tree preserved by petrification, the study of a single species of the great vegetables of the coal ought to be pursued at the same place on a great number of specimens. This is always a difficult task. But if we consider that before we are able to become well acquainted with any species of fossil plant, and especially to get a view of its stratigraphical and geographical distribution, we have to examine it closely at a great number of distant exposures, the difficulties of this study appear far greater.

The collecting of specimens and their study would be greatly encouraged by some good work with descriptions and figures of American fossil plants. Indeed, I have been repeatedly asked what were the books from which we could get that preliminary acquaintance of fossil plants which is necessary to direct such researches. Hitherto nothing has been done in that line in the United States; at least nothing that can be easily obtained by the student, because all that has been published on the botanical palæontology of the coal is disseminated in scientific Journals or State Geological Reports that are not generally accessible.

Before the publication of the Geological report of the State of Pennsylvania, a few species of our fossil plants had been described by Mr. Brongniart in his *Fossil Flora** from specimens sent to him, chiefly by Prof. Silliman, from Wilkesbarre and Zanesville. After this, Mr. Bunbury of England published in the Quarterly Journal of the Geological Society of London (vol. ii, p. 82) some remarks on species of fossil plants collected by Mr. Lyell at Frostburg, Maryland. Very few of these species are described or even determined, for except *Neuropteris cordata*, *Pecopteris arborescens*, *Lepidodendron tetragonum*, *Lepidodendron aculeatum*, *Stigmaria ficcides*, *Asterophyllites* and *Calamites nodosus*, all the species mentioned in Mr. Bunbury's paper are marked with signs of doubt. The general remarks of this celebrated English author are very interesting indeed, but are useless for one beginning the study of the fossil plants of our coal measures. Even the three new species which he has described and figured are uncertain, being made from incomplete specimens. In the third volume of the same Journal, Mr. Bunbury, examining some fossil plants from the Nova Scotia coal measures, sent to him by Mr. Richard Brown, mentions, mostly without descriptions, and with a ?, forty-eight species, of which seven are described and figured. The same remark as above can be applied to these species, except for *Lepidodendron tumidum* and *Neuropteris rarinervis*, satisfactorily described and figured, though still from imperfect specimens. This Journal, vol. iii, No. 1, contains a *Notice of vegetable impressions* by Granger,

* *Histoire des Vegetaux Fossiles.*

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who has given some figures, but without names and scientific descriptions. This Journal, vol. xxix, 1st series, contains an excellent and elaborate article by Dr. Hildreth of Marietta.* A number of our common species of fossil plants are figured in the plates accompanying this paper; but the names and the descriptions of the plants are not given. The remarkable observations of Steinhaur in the *Transactions of the American Phil. Soc. of Philadelphia,* (vol. i, new series) apply to plants observed and examined in the coal basin of England; and those of Harlan in the same journal (1831) concern only some *Fucoides* and have no relation to the coal. These are all the materials which were available for studying the American fossil plants of the coal when I began the examination of the fossil flora of Pennsylvania in connection with the Geological survey of that state. The Report made on this subject contains the description of two hundred and thirty-one species of fossil plants, with figures of one hundred and two of them, mostly new. This number certainly embraces the greater part of the fossil plants of our coal measures. But the report made at the time with all the care and the light which the collected materials could afford is still defective in many points.† Some species considered and published as new, had been described and published previously; and some others supposed identical with European species, are now acknowledged as distinct. Moreover this report, like those numerous geological reports published among us at the cost of the States, is not on sale and can be found only in certain public libraries, and in the hands of a few privileged men of science.

About the same time that this report was made, Dr. Newberry of Cleveland, published in the Annals of Science of Cleveland, a series of papers, the two first of which (Feb. 1st, and Feb. 15th, 1853) contain a catalogue of one hundred and twenty-seven species of fossil plants of which twenty-two are marked with a ? or without name. In the same Journal (March 1st, May 1st, May 15th, 1853, and Jan. 1854), the same author gives a description with figures of a few species, especially fruits. These papers are now difficult to obtain.

To complete the list of what has been published on the fossil plants of this continent, I have to mention still, some very interesting papers on species of coal plants in Nova Scotia, and on the traces of vegetable organs found in the coal, by Prof. J. W. Dawson of Montreal. The same author has enumerated in his *Acadian Geology* about one hundred species of fossil plants belonging to the coal fields of Nova Scotia. Lately Mr. Horatio C. Wood has furnished to the Proceedings of the Academy of Natu-

* *Observations on the Bituminous Coal deposits of the Muskingum Valley, &c.*
† This Journal, July, 1860, vol. xxx, p. 64, note.

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ral Science of Philadelphia (June, 1860,) a paper containing descriptions and figures of some species of *Sigillaria* and *Lepidodendron*.

If in addition to these local papers scattered in periodical works I mention a catalogue of fossil plants published by the writer for the Scientific Society of Pottsville, Penn., I think that we have here the whole amount of contributions to the fossil flora of our coal measures of America.

The larger number of books on fossil plants have been published in Germany and mostly in the German language. In the beginning of this century, Schlotheim published his *Flora der Vorwelt*, with fourteen plates.* Since then science has made such progress that, with the exception of the figures which have been copied by subsequent authors, this work, very remarkable indeed at the time of its publication, is scarcely of any value to the student. From 1821 to 1838 Count Sternberg labored and gave to the scientific world a *Versuch einer geognostich botanischen Darstellung der Flora des Vorwelt*† in two folio volumes. This work contains a great number of good figures of fossil plants which cannot be found elsewhere, and is indeed very valuable for the great amount of information that it contains. It bears the mark of its early origin, and traces of uncertainty by a close and excellent observer who had to find his path in a new field, and give an account of things that had never been seen before and that have no relation to what we have now on hand for a comparison, in the vegetation of our world. *Sternberg's Versuch* was made with great labor and expense, and with the assistance of two of the best German Palæontologists: Corda, who prepared sketches for comparative phytotomy of the fossil and recent plants;‡ and Presl, who elaborated the greater part of the second volume of the book.

Corda, who has been just mentioned in connection with Sternberg, published afterwards his observations in a separate work, *Beitrage zur flora des Vorwelt.* This book is of great scientific interest for the study of the anatomical structure of the wood of some species of fossil trees. A few of the conclusions of the celebrated German author concerning the affinity of stems of the coal with plants of our time are indeed subjected to controversy, but his work in patience and detail of execution is truly admirable. It is still the best guide to consult for those who have opportunity to study the anatomical fossil botany from ground and polished lamellæ of silicified wood.

* I mention only the most interesting of the works published in Europe on the fossil botany of the coal, and especially those that can be purchased.

† There is a translation of this work in French.

‡ *Skizzen zur Vergleichenden Phytotomie vor und jetztwettlichen Pflanzen Stämme.*

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Prof. H. B. Göppert of Breslau has worked immensely upon the fossil flora of the coal. But unhappily some of his memoirs are disseminated in scientific journals. The most important of them which can be got by purchase are, 1st, the *Systema Filicum Fossilium* (1836), descriptions in Latin, explanation in German, and good plates: the *Gattungen fossilien Pflanzen*, (six livraisons have been published), with text both in German and in French. The work is splendidly illustrated; the *Flora des Uebergangs gebirges*, Latin and German: the *Monographie der Fossilen Coniferen*, (Leiden, 1850), and the *Fossile Flora des Silurischen, Devonian*, &c., Leopold Academy, Jena, 1860. This last I have not seen yet, but it is considered as very valuable. It is certain that no living man knows more about the fossil flora of the coal and perhaps of all the formations* than Prof. Göppert. Perhaps his writings are only too numerous and his scientific riches too large. His Genera of Fossil Plants is only commenced and the completion of it is to be ardently desired by every student of fossil botany. In connection with Berger, Prof. Göppert has also published a monography (*De fructibus et seminibus in formatione lithanthracum*) of the fruit of the coal measures which is of great interest.

To Prof. F. Unger, who like Göppert has also published many valuable books on the flora of the recent formations, we owe especially a *Synopsis of the genera and species of fossil plants* which, though made without a clear and fixed method, is very useful as containing an account of all the species of fossil plants known up to 1850, the time of its publication. The descriptions (without figures) are insufficient for the beginner.

Prof. H. G. Bronn has published in his *Lethæa Geognostica* a number of fossil plants of the coal.

From Prof. E. T. Germar we have eight livraisons (the last in 1853) of coal plants. The work in folio has very good plates and descriptions, but progresses very slowly.

Gutbier (Aug. v.) published in 1836 a a small work on the fossil plants of the coal of Zwickau. Though it is printed on poor paper and is without pretention to scientific value, this small book contains a great amount of solid information, and will be consulted with pleasure and profit by those who are interested in our coal flora.

The *Versteinerungen der Steinkohlen Formations in Sachsen*, by Prof. Bruno Geinitz (Leipsic, 1855), is a magnificent folio book with splendid tables and excellent figures. It has been made with great care and from the examination and comparison of a great number of specimens. This is probably the best work to

* I would not even make this restriction, if the admirable work of Prof. Heer on the Flora of the tertiary of Europe had not surpassed all that has been published on the fossil plants of the recent formations.

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give a general view of the fossil flora of the coal. Many of our common American species are found described and figured in it. It is indispensable to the student. Prof. Geinitz seems to have taken a point of view entirely different from that of Göppert and both, I believe, have gone too far; this one by multiplying the genera and the species, without characters always sufficient; the other in uniting into one some species certainly distinct. The work of Geinitz is entirely in German. It is to be regretted that it does not give at least a short Latin description for each species.

Goldenberg has made a beginning of a *Flora Sarræpontana Fossilis;* two livraisons only of the work have appeared (1855 and 1857). If it is ever finished it will be a very valuable work indeed. It contains already on the fossil *Lycopodiaceæ* (to which the author refers the genus *Lepidodendron*) and on the fossil *Selagineæ* (to which he refers the genera *Sigillaria* and *Stigmaria*) a great amount of acute and very interesting observations. To Goldenberg we owe the discovery of the fruit of Sigillaria and good details of its structure. He even asserts that he has found the fructification of *Stigmaria ficoides*, and describes it in his generic diagnosis. Goldenberg appears to be one of those true *workmen* of science who spend their time in the mines examining specimens, and collecting them, not for their fine appearance, but to compare and unite the dismembered parts of a species in order to reconstruct the whole; the only way of studying botanical palæontology with advantage to science.

We can scarcely be astonished to find in France only a single representative of the science of the fossil flora of the coal, that of Prof. Ad. Brongniart: for this celebrated author has done so much for the Botany of the Coal measures, that truly his works are beyond comparison and imitation. What a pity that his great *Histoire des Vegetaux Fossiles* has not yet been and probably will never be finished! The last part delivered to science was printed, I think, in 1844. When we look to the details of his comparative botanical anatomy, to the admirable clearness of his classification, to the exactness of his descriptions and of the figures, to every part of his great work, we cannot be astonished that every attempt at classification and description of fossil plants is done in imitation of Brongniart's method, the true foundation of the science. His observations on the *structure of Sigillaria elegans* is a work of anatomical study that is equalled only by that of Dr. Hooker's on the structure of the *Lepidostrobi*, in the memoirs of the Geological Survey of Great Britain. Besides these remarkable works, and among numerous memoirs of Brongniart, the *Tableau des Genres des Vegetaux Fossiles*, and the *Prodrome d'une Histoire des Vegetaux Fossiles* will be studied and

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studied again with constant advantage and pleasure. If the great fossil flora of Brongniart was finished, it would suffice for the study of the coal plants, at least for the general acquaintance so desirable to direct the researches.

From England, we have the *Fossil flora of Great Britain*, by Lindley and Hutton, (3 vols. 8vo). Many species of the coal measures and of the oolitic formations are described and figured in this work, which is certainly very valuable. But it is made without any systematic arrangement and without method. The descriptions are moreover far from being satisfactory and the drawings too artistical or imaginary.

I have already mentioned the remarkable memoir of Dr. Hooker, who is certainly one of the greatest botanists of our time. From polished lamellæ of fossil cones of *Lepidodendron*, he has exemplified the fructification of this genus as clearly and as perfectly as it could have been done from living specimens.*

Artis, *Antediluvian Phytology*, &c., is a good book for the plates, but scarcely of any use now to the student of fossil plants. The same may be said of Mammats, *A Collection of Geological Facts and Practical Observations*, &c. But Witham's work on *the Internal Structure of Fossil vegetables* is, like *Corda's Beyträge*, very valuable to direct the researches of comparative anatomy in the study of the internal structure of the fossil woods. A number of fossil plants of the coal are described and figured in English works on Geology by Lyell, Buckland, Miller, Mantell, &c.

(*To be continued.*)

ART. V.—*On the Production of the Ethyl Bases;* by M. CAREY LEA, Philadelphia.

I MENTIONED in a former number of this Journal that while engaged in the examination of the action of ammonia on certain oxy-ethers, I had met with the experiments of Juncadella and De Clermont, and finding that the production of ethylamine by these reactions had been already indicated, I discontinued my investigations. Subsequently however having occasion to prepare a considerable quantity of ethylamine for other examinations, I determined to ascertain whether the action of nitrate of ethyl on ammonia could not be made use of as a convenient process. Juncadella had already proposed to mix nitrate of ethyl with three or four parts of alcohol, saturate the mixture with dry ammoniacal gas, and heat for two days to 212° in the water bath. This was a rather troublesome process, and a few experiments led me to the following very simple method, which I publish as having given me satisfactory results:

* Mr. Lesquèreux has apparently overlooked Robert Brown's brief, but very interesting paper, in the *Transactions of the Linnæan Society*, vol. xx, part 3, entitled, *Some Account of an Undescribed Fossil Fruit*, which, in a single specimen, completely demonstrates the structure and affinities of *Lepidostrobus*.—EDS.

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Nitrate of ethyl is mixed with an equal volume of strong alcohol. To this mixture is added a quantity of ordinary strong liquid ammonia equal in bulk to that of the mixture. The nitrate of ethyl is thereby precipitated but is nevertheless easily acted upon by the ammoniacal liquid. Three hours in the water bath at 212° is generally sufficient to complete the reaction. As the process goes on the nitrate of ethyl becomes brownish, gradually diminishes and finally disappears. The resulting solution does not contain salts of ammonia and ethylamine only, as has been stated, but *a large quantity of diethylamine and triethylamine.*

As the nitrate of ethyl can be prepared in large quantity with great facility by a modification of M. Millon's process, which will appear with some other papers in the following number of this Journal, I am inclined to think that this process will be found valuable for the preparation of the ethyl bases. It is necessary that the tubes should be strong, and not more than two-thirds full. Bottles hermetically sealed are not to be recommended unless extremely strong. In one experiment I operated with four eight ounce bottles all of which stood the test, but on repeating the process three of the four exploded at once and the fourth subsequently.

The presence of alcohol is far from being essential. Nitrate of ethyl is readily decomposed at 212° by aqueous ammonia, and if the ammonia is in considerable excess, the decomposition is complete in three hours. If the excess is only slight the time required for decomposition is greatly increased. In one experiment where 29 parts of nitrate of ethyl were heated with 57 of liquid ammonia, the decomposition was not complete till at the end of 15 hours. The use of alcohol and the proportions above given are what was found to give the most satisfactory result.

Philadelphia, April 9, 1861.

Art. VI.—*On the Exact Separation of the Ethyl Bases;* by M. Carey Lea, Philadelphia.

It has been known for some time that when ammonia was acted upon by the halogen ethers, the ethylamine produced was always accompanied by a variable quantity of the secondary and tertiary ethyl bases and the ammonium base, and I have shown that the same is the case with respect to the secondary and tertiary ethyl bases in the reactions of oxy-ethers. The ammonium base I have not looked for, but it is doubtless present also. The primary, secondary and tertiary bases resemble each other so closely in their properties that their separation is attended with great difficulty and has generally been effected by the different solubilities of their chloroplatinates.* I find however that it

* Dr. Hoffman has lately described an elegant mode of separation, differing however, entirely from that here proposed, viz. by means of oxalic ether.

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may be accomplished with great ease by means of picric acid. The picrates of the different bases exhibit the most opposite degrees of solubility, the picrate of triethylamine rivalling the picrate of potash in insolubility, while that of diethylamine is soluble to an almost unlimited extent in water, alcohol and ether, without being in the least deliquescent. Its affinity for ether is so great that its concentrated etherial solution will remain exposed to the atmosphere for days in a syrupy condition, gradually crystallizing on the surface, and eventually all through, to a radiated mass. Between these two extremes the picrate of ethylamine occupies an intermediate position and the differences of solubility are so well marked as to render the separation perfectly easy in the manner to be indicated below.

1. *Separation of the mixed bases from Ammonia.*

This has been generally directed to be done by treating the mixed hydrochlorates either with absolute alcohol, or with a mixture of strong alcohol and ether, whereby the salammoniac is supposed to be left undissolved.

This process I have always found to the last degree unsatisfactory, and necessarily so; for if absolute alcohol be allowed to stand over salammoniac in powder for a time and then be evaporated in a watch glass, a certain quantity of salammoniac will be deposited and the same is true of a mixture of strong alcohol and ether. By operating on the ammonias in the form of sulphates a much more satisfactory result is obtained. For this purpose the mixture as poured out from the pressure tube is treated with a sufficient quantity of pure sulphuric acid to displace the nitric acid (or if bromid or iodid of ethyl have been employed, the bromhydric or iodhydric acid) and the solution is evaporated as far as possible at a temperature of about 250° F. The pasty mass is exhausted with strong alcohol, the alcoholic solution is evaporated as far as possible at the same temperature and the residue exhausted with a small quantity of absolute alcohol. Two exhaustions at least, are necessary even when absolute alcohol is used the first time. In this way a satisfactory result is obtained, which cannot be accomplished with the chlorhydrates.

2. *Separation of the mixed bases from each other.*

TRIETHYLAMINE.

After being completely freed from ammonia as above described, the mixed sulphates were distilled with caustic potash, in the usual way and the bases were saturated with crystallized picric acid. Sufficient heat was applied to redissolve the precipitate which formed toward the close of the saturation, and the hot (not too concentrated) solution allowed to crystallize. The first

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crop of crystals thus obtained were purified by several re-crystallizations, the chlorhydrate of the base was formed and from this the chlorplatinate which was obtained in large and beautiful crystals. The platinum salt was analyzed.

·4858 gms. substance gave ·1567 platinum,	Per cent.
This corresponds to	32·26
Chloroplatinate of triethylamine contains	32·23

The close correspondence of the result with the number given by theory indicates the perfect purity of the triethylamine. Its proportion is but inconsiderable compared with that of ethylamine and diethylamine, and it is chiefly contained in the first portion of the gaseous products which pass over in the distillation with caustic potash.

Picrate of triethylamine crystallizes in delicate yellow needles, which dissolve sparingly in cold water and alcohol, abundantly in hot. The decrease of solubility in an aqueous or alcoholic solution as it cools is very sudden, so that a hot solution deposits almost the whole of the salt as it begins to cool. Placed on platinum foil and gently heated, it melts, turns first red, then black, at the same time boiling up, takes fire, and leaves a residue of charcoal.

ETHYLAMINE.

After the least soluble salt had been removed in the manner just described, the mother water deposited another crop of crystals, which were purified by repeated recrystallization, the chlorhydrate of the base was formed, and its chlorplatinate was analyzed.

·4429 gms. substance gave ·1728 platinum,	Per cent.
This corresponds to	39·02
The chloroplatinate of ethylamine contains	39·29

Picrate of ethylamine presents great differences of appearance according to accidental circumstances. When first crystallizing out of the mixed solution it usually forms groups of short brown prisms adhering to the bottom of the basin. If these be recrystallized we obtain long yellow flattened prisms and laminæ, extending in every direction through the liquid—few substances exhibit more beautiful crystallization. A dilute alcoholic solution often deposits flat prisms bevelled at the extremities, and sometimes hexagonal plates.

In solubility in water this substance approximates to the picrate of ammonia, to which, after it has been subjected to repeated recrystallizations, it bears considerable resemblance in appearance.

DIETHYLAMINE.

After the picrate of ethylamine has been for the most part removed, the mother waters exhibit a curious phenomenon which

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greatly simplifies the further purification of the diethylamine salt left in solution. When these mother waters have been a little reduced by spontaneous evaporation or by a gentle heat, the liquid spontaneously separates into two layers, a pale yellow lighter and a dark brown heavier. The evaporation is continued until the heavier layer constitutes rather more than half of the whole, and then the two layers are separated either at once by a separating funnel, or ether may be added and thoroughly shaken up, when the brown layer dissolves in the ether and rises to the top. After separation it is allowed to crystallize and is once or twice recrystallized from a small quantity of ether by which it is obtained quite pure. A specimen was converted into chlorhydrate and then into chlorplatinate, and gave the following results on analysis:

·3884 gms. substance gave ·1377 platinum.	Per cent.
This corresponds to	35·45
chloroplatinate of diethylamine should contain	35·45

It appears therefore that the salt obtained in the above described manner is perfectly pure.

Picrate of Diethylamine without being deliquescent is soluble to almost any extent in water, alcohol and ether. By spontaneous evaporation it crystallizes in a radiated mass. Sometimes at the bottom of the vessel beautiful transparent brown yellow crystals form, which belong to the monoclinic system. Combination observed $\infty P\infty$, $[\infty P\infty]$, $0P$, ∞P, $+P$, and a clinodiagonal doma.

The approximate proportions in which the different ethyl bases were produced by the reaction here made use of were perhaps ten per cent of triethylamine, thirty or forty of diethylamine and fifty or sixty of ethylamine.

The method here described gives with facility a very exact separation of these bases. The only precaution necessary to be observed, especially in operating on small quantities, is that the solution must not be too concentrated at the outset, otherwise the picrate of triethylamine will be mixed with picrate of ethylamine. But the delicate needles of the former are easily distinguished from the broader ones and prismatic crystals of the latter, and two or three recrystallizations suffice to separate them completely.

I feel assured that picric acid will be found to be a most valuable reagent in effecting separations of cognate organic bases. It may be doubted if there exists any other acid whose salts taken as a whole exhibit so marked a tendency to ready crystallization, and the great differences in the solubility of picrates of allied bases, adds, as in the foregoing example, to the value of this acid in effecting separations between them.

Philadelphia, April 9, 1861.

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ART. VII.—*On the Path and Velocity of the Guernsey County (Ohio) Meteor of May 1st*, 1860; by Prof. E. W. EVANS of Marietta College.

IN a brief account of this meteor published in this Journal of Science, July, 1860, I gave the most reliable and definite observations which I had been able to collect, bearing on the question of the meteor's path and velocity; I also gave such conclusions as the data seemed to me to warrant. I propose now to review the subject more at length, in the light of all the facts now in my possession; partly in order to state, in a more careful manner, both my conclusions and the arguments by which they seem to me to be established; and partly in order to correct some serious errors, in regard to the data, which appear in former communications on this subject.

Prof. J. L. Smith, of the University of Louisville, in an article published in the January number (91) of this Journal, begins by summing up "all the observations" which he considers "worthy of note respecting the fall of this meteorite." In this summary the statement is repeatedly made, that the village of New Concord, near which the largest stones fell, is nearly east from the village of Cambridge, at which some of the observations which he records were made:—it is also stated that a large number of stones fell southeast of Cambridge. The truth is that New Concord is nearly west of Cambridge, and that not one of the stones has yet been found to have fallen southeast of the latter place.

On the map contained in Prof. Smith's article, the lines of latitude place the fall of meteoric stones full 60 nautical miles farther north than it really occurred; while Parkersburg, the place of a most important observation quoted by him, is placed too far north by about 37 nautical miles. Such errors, if allowed to stand uncorrected, would involve the whole subject of the meteor's path in confusion.

Among the observations which Prof. Smith selects as noteworthy I find the following. "Mr. D. Mackley of Jackson county states that he was standing on the platform of the railroad station in Berlin, 20 miles south of Parkersburg, when he saw in a northeast direction a ball of fire about 30° above the horizon," &c.

The value of this observation will appear when it is considered that there is no railroad passing through any place 20 miles south of Parkersburg, that there is no place named Berlin in that part of Virginia, and that the village of Berlin from which Mr. Mackley saw the meteor is in the state of Ohio, nearly 50 miles west of the point indicated by Prof. Smith. The quotation is substantially in Mr. Mackley's own words (as reported from the

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Cincinnati Commercial by D. M. Johnson, in this Journal, July, 1860), with the exception of the words "20 miles south of Parkersburg," which are added. This mistake is the more unaccountable, because in Mr. Johnson's communication the place of observation is described as 80 miles southwest of Cambridge, while both in Mr. Mackley's letter to the Commercial and in my more complete report of his testimony, from which Prof. Smith elsewhere quotes, the place is precisely designated as Berlin, six miles east of Jackson, Ohio, (vide September number, 1860). But the statement, when corrected, is not of more consequence than several others, which Prof. Smith omits altogether from his list of observations worthy of note; though he afterwards gives them in part, as having been relied upon by Prof. Andrews and myself.

In commenting upon my conclusions, Prof. Smith says:—"as regards the supposed elevation of 40 miles when the first reports were heard, I would simply ask the question, is it possible, with the established views of the conduction of sound by rarefied air, that any conceivable noise produced by a meteorite 40 miles distant from the earth, in a medium quite as rare if not rarer than the best air pump can produce, would reach us at all, or if so, in the manner described by observers?"

I need only say in reply that the writer here attempts to invalidate my conclusions by throwing doubt on premises from which I never reasoned. That the sounds in question were somehow connected with the fall of stones none will deny. That they proceeded from an elevation of 40 miles is a view which might well be received with doubt: it is certainly a view which I never maintained. How the sounds were caused, whether by violent disruption of parts or otherwise, is a question which it would be foreign to the purpose of this article to discuss; but I may state in this connection one important fact relating to them, because I shall have occasion to refer to it again. The successive reports heard at great altitudes in the district where the stones fell, and apparently connected with the descent of the separate pieces through the clouds, were entirely distinct from the one great detonation which was heard at great distances from that district. The former were distinctly heard only over an area of a few miles. The latter shook the buildings from Wheeling, Virginia, to Athens county, Ohio. It is ascertained by careful inquiries to have been heard from Columbiana county on the northeast to within eight miles of Chillicothe on the southwest, and from Knox county on the northwest to the borders of the third tier of counties in Virginia on the southeast: an area of about 150 miles in diameter. At all places within this area, except those near Cambridge and New Concord, it was described as a single sound, a sudden concussion resembling thunder or the

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discharge of a heavy piece of ordnance, followed by a roar of about two seconds in continuance. A merchant of Marietta, happening to be at dinner, suspected it was the explosion of a powder magazine in his store about a quarter of a mile distant. The Parkersburg News says, "the houses shook as with an earthquake." In the counties of Washington, Morgan, Noble, Monroe and Belmont, and in places along the Virginia side of the Ohio river from Parkersburg to Wheeling, those who were within doors very generally attributed it to an earthquake. The windows rattled; and local papers state that the door of an empty house was jarred open at Bellair near Wheeling. The line of direction of the sound from all sides, as distinguished by those who happened to be out of doors, cross each other in the southern (not far from the central) part of Noble county; while the inhabitants of that region thought it was overhead. Prof. Andrews, giving the results of personal inquiries, says, "the people of the northern part of Noble county heard it in a southern or southeastern direction, and not in a northwestern direction towards New Concord." At Zanesville about 12 miles from New Concord, the Courier described the noise, not as a succession of sounds, but as an "explosion." These facts clearly indicate that the great detonation heard at these various places was one and the same sound, and that it proceeded from a point over the interior of Noble county. The most probable locality is five or six miles south of Sarahsville. It was undoubtedly the *first produced*, but the *last heard*, of the successive sounds described as receding to the southeast by witnesses in the neighborhood where the meteoric stones fell; and it was compared by them to the roar of thunder.

Again, Prof. Smith says, "as regards the size of the meteoric, I have but to refer to my experiments made in 1854, and published in the Journal of 1855, to show the perfect fallacy of calculating the size of luminous objects by their apparent discs."

As the above remark is made in reference to my estimate of the size of the meteor, it is but justice to myself to say that I had acknowledged the danger of error from this source, and had only insisted that if the apparent disc and the estimated distance be *assumed* as data, we shall obtain for the diameter of the meteor about three eighths of a mile. (Vide Number 88, July, 1860.)

I may now proceed to the discussion of the meteor's path: and first of all I shall aim to state the data with as much accuracy as possible. It is proper to say that the latitudes and longitudes of places in my first communication on this subject (July, 1860) were inserted by the editors, apparently from common maps. I shall here give latitudes, longitudes, and relative distances of places, as nearly as they can be determined from the most reliable surveys of this part of Ohio yet made; which, so

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far as the distances are concerned, may be supposed near enough for the purpose in view. The accompanying map is on too reduced a scale to be easily made accurate; but it will aid the reader in understanding the following remarks.



In my former estimates I decided upon that path which seemed to agree best with all the observations then known to me. After more thorough investigation it seems better to give first the results formed from a few observations which there is now reason to consider the most reliable; and then to show how nearly the other observations confirm these.

The witnesses on whom I shall most rely are, Willian C. Welles of Parkersburg, a graduate of Nassau Hall, and D. Mackley,* Esq., a lawyer of Jackson, Ohio. My reasons for this selection are, first the superior intelligence of the witnesses; secondly their favorable places of observation, one at a great distance from the meteor's path and the other comparatively near; and finally the great pains taken by each to note the facts accu-

* This name was misprinted Hackley in July number, 1860.

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rately on the spot, with a view to publication. I may add also that I have subjected both of these witnesses to a close examination.

Mr. Welles' place of observation was in the state of Virginia, (lat. 39° 17′, lon. 81° 24′), about three miles east of Parkersburg. His testimony is as follows. He saw the meteor through an opening in the clouds, first appearing about 50° east of north, and disappearing about 20° east of north. It was in sight about three seconds. Its altitude when 35° east of north was about 65°. Of this he is most confident. When asked at what altitude its visible path produced would cut the meridian to the north of him, he pointed from 50° to 55°. It is important to observe that Mr. Welles' judgment as to angles is to be strongly relied upon, because he is somewhat accustomed to astronomical observations.

Mr. Mackley's place of observation was Berlin (lat. 39° 6′, lon. 82° 23′), about six miles nearly northeast of Jackson, Ohio. His testimony is as follows. He saw a brilliant meteor pass over a cloudless space from about 55° east of north to about 40° east of north. It was moving nearly parallel with the horizon. When it first appeared, its altitude was about 30°; at its disappearance it was about two degrees lower. It was in sight about six seconds. Mr. Mackley's account of the manner in which he estimated the angles serves to strengthen confidence in his accuracy. He says that as nearly as he could judge, the meteor appeared at one third of the distance from the horizon to the zenith, and the arc which it described, when projected on the horizon, would be one half the altitude. He states also that he visited the place again in order to determine, as accurately as possible, the points of the compass.

In order now to make a first approximation, let us assume that the path of the meteor, when projected on the earth, would pass through New Concord, (lat. 40° 1′, lon. 81° 45′), on either side of which the heaviest stones fell. The bearing of this line, as shown by the direction of the route along which the stones were scattered, by the direction in which different pieces are ascertained by Profs. Andrews and Smith to have reached the ground, and by the direction to which the successive reports attending their fall receded, must have been nearly northwest. Let us then suppose, by way of trial, that it was exactly northwest. Mr. Mackley saw the meteor from Berlin in a northeast direction. Now these two directions being at right angles to each other, it follows that its real path was nearly parallel with the earth's surface; for otherwise its apparent path could not, under the given conditions, have been nearly parallel with the horizon, as Mr. Mackley declares it was. It follows also that its height above the earth was not far from 40 miles; for the altitude given by Mr. Mackley is from 28° to 30°, and the distance northeast from

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Berlin to the projection of the supposed path upon the earth is about 70 miles.

We may now proceed to correct this first approximation by combining the observations of Messrs. Mackley and Welles. We may assume that the path of the meteor for a short space, such as these two observers saw it traverse, could not have departed very far from a straight line; for it was moving in the highest regions of the atmosphere, and, according to any hypothesis, with immense velocity. Then the line which will best agree with the observations of both, and at the same time, when projected on the earth, pass through New Concord, runs 40° west of north. Let us first consider Mr. Welles' observation: azimuth 35° east of north, altitude 65°. The base line in this case (from Mr. Welles' station to the supposed projection), is 19 miles; the consequent height 41 miles, nearly. This was at a point over the eastern part of Washington county, (*b* on the map). Next take Mr. Mackley's first observation: azimuth 55° east of north, altitude 30°. The base line in this case is 68 miles, and the consequent height (after allowing for the curvature of the earth), 40 miles. This was over the southern part of Noble county, (*d* on the map). Next consider Mr. Mackley's second data: azimuth 40° east of north, altitude 28°. The base line is about 69 miles, and the resulting height 38 miles, nearly. This was over the northern border of Noble county, (*e* on the map). Now by comparing the distances between these stations with the corresponding differences of height, it will be seen that they are not far from proportional; which gives a trajectory between the above limits (from *b* to *e* on the map) not departing far from a straight line, though descending somewhat more in the last part than in the first. But if we suppose the bearing to have been one or more degrees greater or less that 40° west of north, we shall in like manner obtain, from the same observations, a trajectory departing from a straight line altogether too rapidly to be admissible: in the one case, indeed, convex towards the earth; in the other case rising and falling successively within the limits of the atmosphere.

The path now found is consistent with Mr. Welles' approximate estimate of the altitude (from 50° to 55°) at which the arc described by the meteor would, when produced, cut the meridian. In the statements of other witnesses we find as close agreement with those of Messrs. Mackley and Welles as could be expected, from ordinary observers of sudden and startling phenomena. In the neighborhood from eight to ten miles north of Marietta, a considerable number of persons (I mention Jacob Leonhart and two sons, of Bear Creek) caught glimpses of the meteor through the clouds, north and a little west of north, at such altitudes as to show that if its course was nearly northwest, its height was not far from 40 miles over the central and

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northern parts of Noble county. Many persons on the eastern border of Athens county, west of Marietta, saw the meteor in a northeasterly direction, passing from cloud to cloud at such altitudes as to lead to the same conclusion. Mr. John Brabham and several others undertook to show the angle at which the body was descending towards the horizon, and it was such as to give a path not differing widely from the above, when combined either with Mr. Welles' observation or with that of Mr. Mackley. The statements of different observers at the same places of course vary somewhat; but none have been used except those which seemed well attested. The directions were taken, whenever possible, as pointed out by the observers themselves, from their places of observation. Every case of very wide discrepancy in testimony was by this means made to disappear.

Let us now use the data furnished by Messrs. Welles and Mackley for estimating the velocity of the meteor. It is to be observed that its bearing, as above estimated, being so nearly at right angles with the lines of vision of both observers, reduces the velocity almost to a minimum. Now Mr. Welles saw the meteor pass from 50° east of north to 20° east of north, (from above *a* to above *c*), a distance of 11 miles in about three seconds. This gives for its velocity, in the first part of its visible path, $3\frac{2}{3}$ miles in a second. Mr. Mackley estimated that the meteor was visible to him for six seconds. The distance in this case (from above *d* to above *e*) is 18 miles; the consequent velocity three miles a second. Here is as close agreement as could be expected: and in view of the tendency to exaggerate the time, we may presume that neither of these estimates of the velocity is too great; but of the two, that based on Mr. Welles' observation should be preferred, since the shorter interval of time is the easier to estimate with precision.

There is no strong evidence that the meteor was seen further southeast than where it first appeared to Mr. Welles, (*a* on the map), nor further northwest than where it was last seen by Mr. Mackley, (*e* on the map). The distance between these two points, projected on the earth is about 35 miles. In a former communication I gave the testimony of Joel C. Richardson of Warren as tending to show that it was seen over the district where the stones fell; but from a comparison of his statements with those of others in the same neighborhood, I am disposed to admit that he made an error of ten or fifteen degrees in the direction. Rumors of persons in Morgan county having seen the meteor descend nearly to the horizon have, upon investigation, proved groundless.

It was a circumstance very favorable to correct estimates of directions, on the part of observers, that they saw the body through openings in the clouds. From the east side of its path it was not seen at all, as the sky was completely overcast; but

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no pains have been spared to collect and examine all the observations from the west side, by personal communication with the witnesses.

The conclusions which we have derived from the evidence may now be briefly summed up as follows. The course of the meteor was about 40° west of north. It was first seen over the eastern part of Washington County (about lat. 39° 27′, lon. 81° 8′) at a height of 41 miles, nearly. It was last seen over the northwestern border of Noble county, (about lat. 39° 51′, lon. 81° 34′), at a height of 38 miles, nearly. Its velocity relatively to the surface of the earth, was from 3 to 4 miles a second.*

As the time was half past twelve, noon (May 1st), it follows from the results just given, that its velocity in the solar system was from 20⅛ to 21 miles a second.

As the data cannot be claimed to be more than approximations to the truth, the conclusions cannot. I have given the results found by comparing the data of two excellent observers at advantageous posts, as the most likely to be near approximations. These results agree nearly with my first estimates, (July, 1860†), formed by a general comparison of less select data, before the most material statements in Mr. Mackley's testimony, or any part of the testimony of Mr. Brabham and many others, were yet known to me. Any attempt to establish a path differing widely from that now given, whether in the bearing, or in the height above the earth, or in the amount of departure from parallelism with the earth's surface between the points indicated, will cause the statements, not only of Messrs Mackley and Welles, but of all the observers, to clash hopelessly with each other.

These views are entirely inconsistent with the hypothesis that the whole of the blazing body described by witnesses came to the earth in Guernsey county, (from *f* to New Concord, on the map). If the principal mass fell at all, it must have fallen at a great distance beyond. Whether we suppose it was consumed in the air or passed on, there is no difficulty arising from the fact that it was not seen farther to the northwest; for there is abundant evidence that the sky along its path was overspread with clouds, not only from Northwestern Virginia to New Concord, but to a considerable distance beyond; and I have ascertained from meteorological reports recorded in the Smithsonian Institution that there were clouds, (early in the afternoon, May 1st), over a large part of Northwestern Ohio. Nor is there any difficulty in conceiving how different bodies of the same density, after entering the atmosphere together and moving through it a

* Assuming that these stones are of extra-terrestrial origin, their velocity on *entering the atmosphere* was greater than 4·9 miles per second, the velocity necessary to a circular orbit. Otherwise the major axis of their orbit would be less than 4000 miles, and the orbit traced backward would again enter the atmosphere.—Eds.

† Vol. xxx, 296.

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great distance, could have been so far separated. For the smaller bodies having more surface in proportion to their weight than the larger, (the surfaces being as the squares of the diameters while the solidities are as the cubes), would encounter more resistance from the air. And the smaller bodies, having once fallen below the larger, would receive a still further acceleration to their descent from the increased density of the air; for it is an established fact that, through atmospheric strata of equal depth, the increase of density downwards is by a geometrical ratio. In order however to account for a separation of over 80 miles in a vertical line it is necessary to concede that the part which passed over was much larger than any of those which came to the ground. It must also be conceded that they began to separate long before crossing the Ohio river: a view which is strongly supported by the fact already stated, that over the southern part of Noble county the stones which fell had already descended far enough to cause a concussion in the lower atmosphere that was heard over a vast region.

For other particulars of the history of this remarkable fall of stones, and for a chemical analysis of some of the specimens, the reader is referred to this Journal for July, 1860, and January 1861.

Marietta, Ohio, May 1, 1861.

Art. VIII.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxxi, p. 26, Second Series, 1861.)

No. 271. *Carex Norvegica*, Wahl. Schkuhr, Car., fig. 66.

Spica oblonga composita; spiculis 3–5 brevi-oblongis sessilibus androgynis infirne staminiferis remotiusculis sub-densifloris, et infima squamoso-bracteata cum bractea longa-setacea; fructibus *distigmaticis* ovatis vel oblongis ellipsoideis subacutis ore integris apiculatis squama late-ovata subacuta paulo longioribus vel subaequantibus.

Culm 6–10 inches high, erect, leafy below, longer than the leaves; spikelets 3–5, oblong, short, sessile, staminate at the base, a little separated below, a setaceous and rough bract supporting the lowest and rising from an ovate scale; stigmas two; fruit ovate, oblong or ellipsoid, somewhat acute and apiculate with entire orifice, slightly compressed, longer than or equalling the ovate, short, broad and acutish scale.

Long known on the sea-shores of Norway, it was discovered in 1860 at Wells, Me., in marshes, near the ocean, and forwarded to Dr. Sartwell by Rev. J. Blake, thus being first detected in our country.

No. 272. *C. Franklinii*, Boott, in Hook. Fl. Am. Bor., 217, Illust., No. 193.

Spica e spiculis multis diversis fuscis composita; spiculis 6–10, superne aggregatis quatuor vel pluribus sessilibus nunc ovatis oblongis nunc linearibus gracilibus, suprema apice staminifera, proximis toto staminiferis

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vel non-floriferis, inferioribus supernè staminiferis interdum toto pistilliferis exserto-pedunculatis vaginato-bracteatis nutantibus; fructibus *dis vel tristigmaticis* ovatis oblongis vel ellipticis scabris ore bifidis fuscis, squama oblonga vel ovali scabra fusca acuta paulo longioribus.

Culm sometimes two feet high or more, triquetrous, slender, stiff and erect, leafy towards the base; leaves long and narrow; spikelets very dissimilar, the pistilliferous ovate-oblong or oblong-elliptic, the lower slender pedunculate and nodding, several upper ones sessile and clustered at the summit, the terminal staminate at the apex and near the small and slender-linear staminate or flowerless spikelets; stigmas 2 or 3, as both numbers occur; fruit elliptic or ovate, oblong, compressed, scabrous and tawny with a bifid orifice, with scales ovate or oval, acutish, rough, and nearly equal to the fruit.

Rocky Mountains, *Drummond.*

Resembles C. ovata, *Rudge*, in having stamens above and three stigmas, but differs much, and is strikingly characterized, as is shown by the only specimens from the Rocky Mountains. For C. ovata, see this Journal, vol. x, p. 44, 1826.

No. 273. *C. incurva*, Lightfoot. Schk., Car., fig. 95.

Spica brevi composita; spiculis 5–8 ovatis sessilibus dense-aggregatis squamoso-bracteatis spicam staminiferis capitulum ovatum sub-rotundum flavum formantibus; fructibus *distigmaticis* ovatis convexis tereti-rostratis, squama ovata longè acuta longioribus vel aequantibus; culmo 5–7 unciali saepe incurva.

Culm 5–7 inches high, suberect, often incurved, scarcely longer than the narrow, flat, light-green leaves rising from the base; spikelets 5–7, sessile and ovate, densely clustered into a roundish head half inch long, staminate at their apex; stigmas two; fruit ovate, tapering-rostrate, convex or slightly ventricose, and immature is shorter than the ovate, long-acute scale; light green, except the yellowish head or spike.

High or cold northern parts of Europe; British America, *Dr. Richardson;* Rocky Mountains in Western Nebraska, *Dr. F. V. Hayden.*

Note. The following new species or forms were collected in the "Yellow Stone and Missouri Exploring Expedition" of the United States, in the northwestern part of Nebraska Territory, under the command of W. F. Raynolds, Capt. Topographical Engineers, during 1859 and 1860, and are published by authority of the Secretary of War; Dr. F. V. Hayden, Geologist and Naturalist of the Expedition.

No. 274. *C. Raynoldsii*, Dew.

Spicis distinctis; spica staminifera solitaria terminali ovata brevi-subconica subsessili densiflora squamis oblongis obtusis vel subacutis rufis obtecta; pistilliferis 3–5 oblongis ovatis vel brevi-cylindraceis crassis densifloris, superiore 1–2 sessili brevi parva et vicina, ternis inferioribus plus vel minus pedunculatis foliaceo-bracteatis vix vaginatis, infima longo-pedunculata subremota et declinata; fructibus *tristigmaticis* rotundo-oblongis ellipsoideis obtusè triquetris nervatis apicem nigris brevi-apiculatis ore subbilobis, squama lata ovata brevi-acuta vel submucronata nigro-fusca duplo longioribus vel paulo superantibus; culmo 20-unciali

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laevi subtriquetro basin foliaceo et vaginato, foliis crassis planis nervatis longiore; foliis forma juniore flaccidis et omnibus laevibus.

Culm about 20 inches high, erect, stiff and smooth, leafy towards the base, and bracteate under the lower spikes; leaves flat, curved, stiff in maturity, but flaccid earlier, slightly rough on the upper part of the edges and shorter than the culm; staminate spikes single, ovate, short-conic; pistillate spikes 3–5, ovate-oblong or short-cylindric, thick and close-flowered; when 4–5, the upper 1–2 spikes short, small and near the staminate, the three lower pedunculate, leafy bracteate, scarcely vaginate, the lower longer and more remote, and the lowest long, pedunculate and some declined; stigmas three and short; fruit oblong, ellipsoidal, round, triquetrous, ovate or sub-cylindric, nerved, black at the short opening apex, orifice sometimes bilabiate, as long as or near twice as long as the broad-short-ovate short acute scale or sub-mucronate tawny-black scale.

Pierre's Hole, valley of Snake River, June 20, 1860, 6000 ft. alt.; and Henry's Fork, June 22, 1860, 5500 ft. alt.—*Dr. F. V. Hayden.*

A distinct and fine species, not to be confounded with either C. nigra, *All*, which has androgynous spikes staminate *above*, or with C. atrata, *Lin.*, which has spike staminate *below*, as well as different fruit; for the last see this Journal, vol. x, p. 271, 1826.

No. 275. *C. vallicola*, Dew.

Spica composita oblonga ½–1 unciali; spiculis 4–7 ovatis sessilibus brevibus parvisque apicem staminiferis nunc approximatis nunc remotiusculis, inferiore squamaceo-bracteata; fructibus *distigmaticis* obovatis substipitatis convexo-concavis brevi-rostratis ore obliquis enervatis, squama lata ovata subacuta dorso fusca margine albo-membranacea paulo longioribus vel subaequantibus; culmo gracili foliis angustis longiore. Interdum spicis nullo flores pistilliferos habentibus, forte non floriferis.

Culm 6–12 inches high, slender, erect, triquetrous, scabrous and naked above, narrow-leafy towards the base; spikelets 4–7, ovate and sessile, near or more remote below, at the apex staminate with close ovate scales on a short cylinder terminating above and especially the upper ones; the lower spikelets scaly-bracteate; stigmas 2; fruit obovate, tapering below, rostrate and stiped, at the orifice oblique, equalling or a little exceeding the broad-ovate subacute scale which has a tawny back and white membranous margin.

Jackson's Hole, on Snake River, June 18, 1860, 6000 ft. alt.—*Dr. F. V. Hayden.*

Differs from others of this family in having the staminate part of the spikelet a short projecting column or cylinder at the apex, often longer than the pistillate part, and having its closely appressed ovate scales.

No. 276. *C. Douglasii*, Boott, Hook, Fl. Am. Bor., tab. 214.

The common form of this species, as found by Dr. Hayden in Nebraska Ter., a few years since, was described in this Journal, vol. xxiv, p. 46, 1857. In 1860 he collected specimens, as described by Dr. Boott, towards *a foot high, with spikelets androgynous and staminate at the apex, with others wholly staminiferous;* and also another form *wholly pistilliferous* and so different in its compound spike as to be ranked as a very clear variety, if indeed it belong to this species. It is here described as

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Var. *densi-spicata*, Dewey.

Dioica; spica staminifera e spiculis 5–8 ovatis aggregatis composita cum squamis lato-ovatis oblongis obtusiusculis castaneis margine albis; spica composita omnino pistillifera 1–1½ unciali et semi-unciali-lata crassa; spiculis 15–20 vel pluribus ovatis ellipsoideis, superne singulis et arcte congestis, inferne paulo remotis ramosis vel divisis et arctis, densifloris fructibus *distigmaticis* ovato-lanceolatis rostratis bifidis (immaturis), squama lanceolata castanea dorso viridi margine alba paulo brevioribus; culmo 3–5 unciali erecto laevi rigido, foliis planis vaginatis subradicalibus.

Culm 3–5 inches high, smooth, rigid, erect and shorter than the flat, sheathed and subradical leaves, and wholly pistilliferous; spike 1–1½ inch long and half inch broad, thick, composed of 15–20 ovate spikelets densely aggregated above, and below less near and subdivided or branched, all forming a compact, long head; stigmas two; fruit lanceolate-rostrate, slightly rough on the beak (immature), orifice oblique, bifid, shorter than the lanceolate scale.

Jackson's Hole, on Snake River, or Lewis' Fork of the Columbia, on gravelly knolls, June 15, 1860, 6000 ft. alt.—*Dr. F. V. Hayden.*

Differs from C. Nuttallii, Dew., (Sill. Journ., vol. xliii, 1842,) in its spike and inflorescence, and its relatively broad leaves, as well as its fruit being much less convex and ventricose.

ART. IX.—*Remarks on the Mesozoic Red Sandstone of the Atlantic Slope, and notice of the Discovery of a Bone Bed therein, at Phœnixville, Penn.;* by CHARLES M. WHEATLEY, M.A.

[Read before the Connecticut Academy of Arts and Sciences, Feb. 20, 1861.]

No question in American geology seems more difficult of elucidation, than the age and geological position of the so-called "New Red Sandstone" of the Atlantic slope; some geologists referring it to the Oolitic or Liassic periods, others to the Trias, and others still lower, to the Permian. The true position may probably be determined like the San Casciano beds, intermediate between the Triassic and Liassic periods forming a separate group containing like those beds, its own peculiar fossils. No true Permian forms—characteristic of that formation have yet been discovered; the fishes formerly referred to Palæoniscus, are now placed in the genera Catopterus, *Redfield,* and Ischypterus, *Egerton*, their tails being more homocercal than heterocercal. The Clepsisaurus, *Lea*, once considered a Thecodont Saurian and analogous to *Thecodontosaurus antiquus* of Riley and Stutchbury from Redland, near Bristol, England, (found in dolomitic conglomerate referred to the Permian, but now considered not older than the Triassic,) is stated by Dr. Leidy (Proc. Acad. Nat. Sci. Phila., 9 June, 1857,) to be "not properly a Thecodont reptile but may form the type of a new species as its teeth are inserted

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in the jaws by solid conical fangs." The whole formation is moreover destitute of beds of rock salt and gypsum which characterize mineralogically the Permian system, not only in Russia but wherever recognized. Sir R. I. Murchison (Quar. Jour. Geol. Soc., Lond., vol. i, p. 82,) says, "The Triassic system does not contain a single Palæozoic form whether animal or vegetable whilst the fauna and flora of the Permian are both so connected with the Carboniferous and inferior systems, that they evidently constitute the last remnant of the same era. In the whole geological series, therefore, no two systems are more completely separated than the Permian and the Trias, the one forming the uppermost Palæozoic stage, the other the base of the Secondary deposits."

Prof. Henry D. Rogers in his final Report on the Geology of Pennsylvania, vol. ii, part 2, p. 695, says, under the head "Organic Remains of Main Red Sandstone belt of Atlantic slope," "Reptiles,"—"the main formation or that which alone passes across Pennsylvania, has thus far disclosed the remains of several interesting species: two of these the *Clepsisaurus Pennsylvanicus* and *C. Leai, were first discovered as already intimated in Pennsylvania:* and a species, probably the first named, has been since recognized in the Deep River coal field at North Carolina nearly a prolongation of the same, by Dr. Emmons, who has added several other species of reptiles as belonging to the deposit in North Carolina, namely *Rutiodon Carolinensis, Palæosaurus Carolinensis,* and *Palæosaurus sulcatus.* In New Jersey the formation has disclosed the remains of another reptile of the same general structure as the Clepsisaurus; it has been named by Mr. Lea who discovered it, the *Centemodon sulcatus.*"

Prof. Rogers has mistaken the localities, the only Saurian bones discovered in Pennsylvania at the date of his remarks were, vertebra, ribs, and teeth found in the calcareous conglomerate near Hassacs Creek, upper Milford Township, Lehigh county, by Dr. I. Y. Shelley, who presented them to the Academy of Natural Sciences, Phila., Nov., 1847, and upon which Mr. Lea founded his *Clepsisaurus Pennsylvanicus,* (Journal Acad. Nat. Sci. Phil., Part 3, 1853, page 185, &c.); a visit to the locality by Mr. Lea "with Dr. Shelley failed to discover the smallest indication of further specimens," and until my discovery of the bone bed at Phœnixville in October, 1860, these were the only Saurian bones found in the State, with the exception of a portion of a rib sent by the writer to Mr. Lea, noticed in Proc. Acad. Nat. Sci. Phil., 2 June, 1857.

Clepsisaurus Leai Emmons, (*Omosaurus perplexus* Leidy) American Geology, part 6, page 81, fig. 51, mentioned by Prof. Rogers as *first discovered in Pennsylvania, has never yet been recognized in this State,* but was described by Prof. Emmons from Saurian bones found in the Dan River formation near Leaksville,

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North Carolina. Prof. Leidy thinks Omosaurus probably a distinct genus from Clepsisaurus. Prof. Emmons gives Omosaurus perplexus, *Leidy*, as a synonym of both Clepsisaurus Leai, and Rutiodon Carolinensis.

Centemodon sulcatus, Lea, stated by Prof. Rogers as discovered by Mr. Lea in *New Jersey*, was described from a single tooth, found by Mr. Lea in the black bituminous shales of *Phœnixville Tunnel, Pennsylvania*, (Proc. Acad. Nat. Sci. Phila., viii, p. 77, March, 1856), no other remains of Centemodon have as yet been described.

The following fossils have been noticed in the "Mesozoic Red Sandstone" of Pennsylvania:

PLANTS.

Equisetum columnare, Brong., 15 to 16 inches long, and 7 inches circumference in sandstone of a dark grey color, with iron pyrites, Phœnixville.

Pterozamites longifolius, Emmons, in grey micaceous sandstone, with iron pyrites, Phœnixville.

Gymnocaulus alternatus, Emmons, in light micaceous sandstone, Phœnixville.

Fir-Cones, 6 in. long, 1 in. wide, Isaac Lea, this Jour., [2], vol. xxii, p. 123, 1856, in black bituminous shales, Phœnixville.

Plant resembling that fig. by Emmons, as *Calamites punctatus* in black bituminous shales, Phœnixville.

Plant resembling Noeggerathia at Gwynned, I. Lea (Am. Jour. of Sci., vol. xxii, 1856, p. 123,) probably same as fig. by Emmons (N. Car. Rep. pl. 1, fig. 3,) as Dictyocaulus-striatus, and which Prof. O. Heer (this Journal, [2], vol. xxiv, p. 428,) says "has an obvious resemblance to Noeggerathia." Leo Lesquereux says the genus Noeggerathia, Göpp., entirely disappears at or before the beginning of the coal epoch, (this Jour., [2], vol. xxx, p. 380.)

A number of plants, seed vessels, &c., have been found in the grey micaceous sandstone and black shales, at Phœnixville, the genera of which are yet undetermined.

CRUSTACEA.

Estheria ovata, (Posidonia ovata, *Lea*.)

Estheria parva, (Posidonia parva, *Lea*,) in black bituminous shales, Phœnixville.

Cypris, two species, one smooth, the other beautifully granulate, in black shales, Phœnixville, Rogers, also at Gwynned, J. Leidy, (Proc. Acad. Nat. Sci. Phil., 16 June, 1857).

Limulus? Fragment of Shield probably Limulus, black bituminous shales, Phœnixville, other remains probably Crustacean have been found in black shales, Phœnixville.

MOLLUSCA.

Myacites Pennsylvanicus, Conrad, Proc. Acad. Nat. Sci. Phil., 1857, p. 166, and 1860, plate 1, fig. 3.

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FISHES.

Single ganoid scale, in black bituminous shales, at Gwynned, Isaac Lea, this Jour., [2], vol. xxii, 123, 1856, "more like *Pygopteris mandibularis* Ag., than any other which had come under Mr. Lea's notice."

Scales, bones and teeth of ganoid fishes are abundant in black bituminous shales at Phœnixville. Scales have been found by Dr. Leidy also at Gwynned, Proc. Acad. Nat. Sci. Phil., 9 June 1857.

Turseodus acutus, Leidy, Proc. Acad. Nat. Sci. Phil., June, 1857, page 167, "This genus and species are founded upon a left dental bone with teeth, probably of a ganoid fish which I obtained from the black shale of what have been usually considered the Triassic rocks from near Phœnixville, Chester Co., Pa. The dental bone is 20 lines long, by 4 lines in depth; posteriorly, it is straight, and its outer surface is covered with fine, interrupted ridges, such as are observed upon small ganoid scales, found in the same series of rocks at Gwynned."

"Upon the dental border of the specimen there may be counted the remains of 20 teeth, situated at irregular intervals, they have measured from ½ to 1 line long, they are columnar in form, slightly curving inward; have a spreading base, and an abrupt, conical, enamel summit, the fish may be allied to Belonostomus, or Eugnathus, but I am unable to ascertain the exact form of the teeth in these genera."

Radiolepis speciosus, Emmons. *Family Cœlacanthi*, scale discovered at Gwynned, by Isaac Lea, in black bituminous shales, Proc. Acad. Nat. Sci. Phil., 7 July, 1857, also at Phœnixville.

Catopterus gracilis, Redfield. Scales, bones and teeth similar to those from Richmond, Va., and North Carolina, are found in bituminous shales at Phœnixville.

REPTILIAN REMAINS.

Clepsisaurus Pennsylvanicus, Lea, Journal, Acad. Nat. Sci. Phil., new series, vol. ii, 1853, p. 185, founded on vertebra, ribs and teeth discovered in calcareous conglomerate, upper Milford Township, Lehigh county, teeth supposed to belong to this reptile have been discovered by Dr. Leidy in black bituminous shales at Phœnixville, Proc. Acad. Nat. Sci. Philad., 1859, p. 110.

Eurydorus serridens, Leidy, Proc. Acad. Nat. Sci. Phil., 1859, p. 110, founded on tooth "large size, compressed, conical, opposite acute serrulated borders," discovered by Prof. Leidy in black bituminous shales, Phœnixville.

Composaurus —— ? Leidy, Proc. Acad. Nat. Sci. Phil., 1859, p. 110, founded on tooth discovered by Prof. J. Leidy in black bituminous shales at Phœnixville, "borders without serrulations, base fluted" "resembles the teeth of Composaurus of the coal of Chatham Co., North Carolina, but nevertheless belongs to a different species."

Centemodon sulcatus, Lea, Proc. Acad. Nat. Sci. Phil., vol. viii, p. 77, March, 1856, founded on a single tooth discovered by Mr. Lea in black bituminous shales at Phœnixville, described in this Journal, [2], vol. xxii, p. 123.

Bones and teeth probably Batrachian, found by Dr. Leidy at Gwynned, Proc. Acad. Nat. Sci. Phil., 16 June, 1857, in black bituminous shales, also at Phœnixville.

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REPTILIAN REMAINS.

Coprolites, very abundant in black bituminous shales at Phœnixville, some of them containing fish remains.

Foot-Tracks, Chelichnus Wymanianus, *Lea*, on dull red limestone? Phœnixville, Isaac Lea, Proc. Acad. Nat. Sci. Phil., viii, 77, 1856.

Ripple marks are also found in the red shale, Montgomery county, opposite Phœnixville.

Section of Strata at Phœnixville Tunnel, Penn., beginning at Eastern entrance, and running about two-thirds through, dip Northwest.

	ft.	in.
Red shale,	5	
Green shale,	6	
Black bituminous shale, containing Saurian bones, coprolites in abundance, Estherias,—remains of ganoid fishes, and Cypris, there are clay concretions about one inch in thickness on upper part, this layer is *full of fossils*.	1	10
Red and green shales, the green slightly calcareous, with traces of Estherias and iron pyrites	11	
Black bituminous shale with scales of ganoid fishes, Estherias and Cypris, fossils not very abundant	1	
Dark green, hard, compact shale, full of clay concretions, traces of Cypris		9
Red micaceous sandstone,	7	10
Brown sandstone, with calcite veins and quartz crystals,	8	6
Hard, compact, red and green shale, with nodular concretions of Limonite, abundantly distributed all through it, forming a "*Hæmatitic conglomerate*,"	5	8
Red sandstone, with remains of plants,	5	6
Red and green shale,	5	2
Red shale, with coprolites and plants, the coprolites inclosing scales of ganoid fishes		10
Grey sandstone with veins of carbonate of lime,	5	5
Fine-grained, red and green variegated shale,	24	0
Black bituminous shale, with Estherias and fish remains in upper part,	6	
Grey compact fine-grained shale,	11	
Olive green shale, with red veins,	1	
Red shale,	7	
Clay concretions in three layers, 1 inch each,		3
Sandstone with veins of dolomite and calcite—in cleavage which is quite vertical,	11	3
Fine-grained micaceous sandstone, estimated,	20	
Fine-grained compact do do	25	
'Vug' or cavity 5 feet wide at bottom of Tunnel, 21 feet high running to a point about two feet above the back of Tunnel, filled with red and green shales, talcose and micaceous *crushed to powder*,		
White talcose shale vertical, 5 feet wide at bottom, 4 ft. at top of Tunnel.		
Red shale fine-grained, compact,	6	8
Strata very irregular for some distance,		
Shale with clay concretions and oxyd of iron,		10
Bone bed, full of Saurian bones, no other fossils noticed,		6
Black bituminous shale with Estherias and coprolites,		6
Fine-grained, hard, compact sandstone, full of stems of plants,	6	

The "bone bed" is situated about 100 feet in the Tunnel from the western end, and is not more than 6 inches thick. Fragments of Saurian bones occur rather abundantly all through the

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layer, but the more perfect bones are found at the bottom of the bed where they are collected together forming from two to three inches of the layer, a seam of white or pink carbonate of lime underlies them and is from $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness. Under this is a very thin seam of black carbonaceous matter, which is grooved and polished like slickensides, evidently showing great disturbing force since the deposition of the bed.

The material composing the bone bed is formed almost entirely of the remains of *Cypris*. No Estherias, Myacites, coprolites or fish-remains, have been observed associated with the Saurian bones in many tons of the shale carefully broken up and examined.

Above the bone bed is about 6 inches of bituminous shale with Estherias and coprolites, over this from 5 to 6 feet of hard, fine-grained sandstone with plants. The bed is underlaid by ten inches of shale with clay concretions which are mostly geodes containing yellow pulverulent oxyd of iron, and under this a compact, fine-grained red shale from six to seven feet to the bottom of the Tunnel.

Near the above in a micaceous dolomitic sandstone of a light grey color, occasionally so calcareous as to effervesce freely in acids, occur Saurian bones—and part of a *jaw* seven inches in length, $\frac{7}{10}$ in. wide, and about $\frac{3}{16}$ in. deep, with seven alveoles about $\frac{3}{16}$ of an inch apart, a *cranial plate* radiated and sculptured $1\frac{1}{2}$ inches long and $1\frac{3}{10}$ in. broad, and an *Icthyodorulite* 3 inches long $\frac{3}{16}$ in. wide at base, remains probably of Batrachians, Estherias, bones, scales, and teeth of ganoid fishes, the scales are large, thick, beautifully ornamented, and coated with a layer of transparent (ganoin) enamel.

Casts of two shells, one may probably be referred to either Pholadomya or Cardita, and the other to Unio or Potamomya and also large quantities of *Saurian teeth*, some of which are full $1\frac{1}{2}$ inches in length, curved, smooth, or finely striated, probably belonging to *Clepsisaurus Pennsylvanicus*, Lea, others curved and sulcate, answering to the description of *Centemodon sulcatus*, Lea. Another perhaps may be *Composaurus*, Leidy, and another of "large size, compressed, conical, with opposite acute serrulated borders" which doubtless is that described by Prof. Leidy as *Eurydorus serridens*. These teeth are found twenty or thirty together and are well preserved, sometimes the teeth are converted into iron pyrites for one half their length, or the pulp cavity alone filled with pyrites, and occasionally small seams of dolomite, calcite, or sulphuret of iron, cross them transversely without disturbing their position. It is remarkable that while the black bituminous shales have afforded but few Saurian teeth, and none have as yet been discovered in the "bone bed," so many should have been collected together and deposited in this

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strata of dolomitic sandstone as to give it the appearance of an osseous conglomerate or bone breccia.

In some instances *the casts* only of the teeth remain, the substance of the tooth being converted into *dolomite* but retaining the exact form of the tooth with the sulcations as distinct as in the original, twenty teeth of probably three or four genera of Saurians, *all converted into dolomite!* occur on a piece of sandstone 6 by 8 inches. It is a singular fact, that while the teeth are dolomitic casts only, the bones in the same stone remain unchanged, retaining their original structure.

Associated with the above fossils in the sandstone are numerous plant remains, mostly of a broad sulcated stem without joints or branches, as far as noticed they retain the same width their entire length, and are from one half to two inches broad and from six to eight inches long.

The shales, sandstones, and fossils of the Phœnixville Tunnel bear a remarkable resemblance to those of Nagpur and Mangali, Central India, described by Messrs. Hislop and Hunter, Quarterly Journal Geological Society, London, vol. x, p. 472, and vol. xi, p. 371, and referred by them to the lower Jurassic age. The following is the descending order of the series according to the observations of the authors:

1. Soft ferruginous sandstone, sometimes hard, with iron bands, and plants.
2. Fine and coarse argillaceous sandstones, rich, with plant remains, these have afforded:—
 Labyrinthodont reptile, Brachyops-laticeps, Owen.
 Fishes, ganoid scales, and small jaws.
 Crustaceans, Estheria.
 Plant remains.
 Fruits and seeds, numerous and undescribed.
 Leaves, Conifer, Zamites, Poacites and Ferns, (Pecopteris, Glossopteris, Tœniopteris, Cyclopteris, Sphenopteris).
 Stems, exogenous and endogenous.
 Acrogens, Aphyllum, Equisetites, Phyllotheca, Vertebraria.
3. Red shales 50 feet, green shales, 30 feet. In the former of these there were observed at Korhádi:—
 Reptilian foot tracks.
 Worm tracks, and intestine shaped evacuations, these were also found in the *green shales.*
 Phyllotheca?
4. White and colored dolomitic limestones.
 Bituminous shales with fossils.
 Sandstone.
 Indurated clay stone.
 Green shale.
 Bituminous shale with fossils.

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The plant-bearing sandstone of Phœnixville Tunnel, though not containing all the genera of plants found in the Mangali strata, is far richer in Saurian remains. Crustaceans (Estherias and Cypris) parts of ganoid fishes, and shells. The green shales of the Tunnel have worm tracks, and the intestine shaped evacuations. The bituminous shales are rich in organic remains. The remains of Conifers, Zamites, Equisetites and probably fruits and seeds, with dolomitic sandstones, indicate a very great similarity with the lower Jurassic Central Indian formation.

Phœnixville, Penn., Feb. 1861.

ART. X.—*On the Classification of Organic Substances by Series;* by JAMES SCHIEL, of St. Louis.

THE progressive series which in 1842* I introduced into organic chemistry, have become the chief means of classification and of connecting organic substances generally. Several years after the introduction of the series, Gerhardt used them in the sense just mentioned in his Traité de Chimie and thereby contributed a great deal toward their general knowledge.† But the idea this distinguished chemist had formed of series was very imperfect, as is proved by the single fact that he ranged benzoic acid and acetic acid in what he called an isologous series (*Traité*, T. I, 127). As in the present state of chemical science, it is highly important that the principles of seriation be clearly understood, I will try to expound them in a more general and methodical manner than has been done hitherto.

The general formula of organic compounds containing carbon, hydrogen and oxygen is $C_\alpha H_\beta O_\gamma$. By giving to γ successively the values 1, 2, 3, 4, ... we may form the following series of oxydation:

(A) $C_\alpha H_\beta O$
$C_\alpha H_\beta O_2$
$C_\alpha H_\beta O_3$
$C_\alpha H_\beta O_4$
⋮

From this all the series necessary for the classification of organic substances may be derived by putting $\alpha=n$ and $\beta=2n+2$, making β successively to decrease, the decrement being 2, 4, 6, 8,

* Annal. Liebig and Wöhler, July number, 1842.

† Gerhardt changed the name progressive into homologous, in the discovery itself of the series he has no share.

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... By this we have the following series:

I.	II.	III.	IV.
$\mathfrak{C}_n H_{2n+2}\Theta$	$\mathfrak{C}_n H_{2n}\Theta$	$\mathfrak{C}_n H_{2n-2}\Theta$	$\mathfrak{C}_n H_{2n-4}\Theta$
$\mathfrak{C}_n H_{2n+2}\Theta_2$	$\mathfrak{C}_n H_{2n}\Theta_2$	$\mathfrak{C}_n H_{2n-2}\Theta_2$	$\mathfrak{C}_n H_{2n-4}\Theta_2$
$\mathfrak{C}_n H_{2n+2}\Theta_3$	$\mathfrak{C}_n H_{2n}\Theta_3$	$\mathfrak{C}_n H_{2n-2}\Theta_3$	$\mathfrak{C}_n H_{2n-4}\Theta_3$
⋮	⋮	⋮	⋮

and so forth.

Every general formula in one of these generic series represents special homologous series the members of which have the difference $n\mathfrak{C}H_2$. When comparing the above series with the hydrocarburets known to exist in a free state, they will be found to represent different states of oxydation of these hydrocarburets.

Another kind of series is formed by making in the general formula $\alpha=n$ and $\beta=n$ and making β successively to decrease or increase, the increment or decrement being 1, 2, 3, 4, ... By this we form the series:

. (B.) $\mathfrak{C}_n H_n \Theta_\gamma$
$\mathfrak{C}_n H_{n\pm1} \Theta_\gamma$
$\mathfrak{C}_n H_{n\pm2} \Theta_\gamma$
$\mathfrak{C}_n H_{n\pm3} \Theta_\gamma$
⋮

Every general formula here represents a series, the members of which are distinguished by $m\mathfrak{C}H$ and which I therefore call *hemilogous* series. It is to be remarked that a hemilogous series whose general formula is $\mathfrak{C}_n H_{n\pm1}\Theta_\gamma$, can only exist when n is an odd number, as the number of atoms of hydrogen entering into an organic compound is always an even number.* The hemilogous series are very useful for comparing the physical properties of organic substances.

I will now apply these principles of classification to three large classes or groups of substances, the hydrocarburets, the alcohols and the acids. The generic series formed by the first of these groups is the following:

$\mathfrak{C}_n H_{2n+2}$ hydrurets of the radicals of the alcohols;
$\mathfrak{C}_n H_{2n}$ the homologues of ethylen and the radicals of the alcohols;
$\mathfrak{C}_n H_{2n-2}$ acetylen n=2; allyl n=6;
$\mathfrak{C}_n H_{2n-4}$ thymen n=10;
$\mathfrak{C}_n H_{2n-6}$ benzol n=6, toluol n=7, xylol n=8, cumol n=9, cymol n=10.
⋮
$\mathfrak{C}_n H_{2n-14}$ stilben n=14;
$\mathfrak{C}_n H_{2n-20}$ hydrocarburet found in the tar of Archangel n=19.

The maximum or minimum number of atoms of hydrogen which may be combined with n atoms of carbon cannot be deter-

* If one atom of nitrogen enters into the compound the atoms of hydrogen are an odd number, as nitrogen is triatomic. For this reason alone the formula of Quinine for instance, could not be written $C_{10}H_{12}N\Theta$, as chemists formerly used to do, but $C_{20}H_{24}N_2\Theta_2$ as it is written now for other reasons.

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mained at present, but there is no hydrocarburet known to contain more than $(2n+2)$ and less than $2n-(n+2)=n-2$ atoms of hydrogen to n atoms of carbon.

The alcohols form several generic series:

Alcoholic series I.

$$\left.\begin{array}{ll} \mathrm{C_nH_{2n+2}\,O} & \text{common alcohols of the type } \mathrm{C_n'\,H_{2n+1}\,H} \\ \mathrm{C_nH_{2n+2}\,O_2} & \text{glycolic alcohols of the type } \mathrm{C_n''\,H_{2n}\,H_2} \\ \mathrm{C_nH_{2n+2}\,O_3} & \text{glycerine } \quad " \quad \mathrm{C_n'''\,H^{2n-1}\,H_3} \\ \vdots & \end{array}\right\}\ \mathrm{O}$$

whether tetracid alcohols of the general formula $\mathrm{C_nH_{2n+2}O_4}$ and the type $\left.\begin{array}{l}\mathrm{C_nH_{2n-2}}\\ \mathrm{H_4}\end{array}\right\}\mathrm{O_4}$ can exist, is not known, as we know nothing certain about the existence of tetrabasic radicals. The polyethylenic glycols of the general formulas

$$\mathrm{C_nH_{2n+2}\,O_4}$$
$$\mathrm{C_nH_{2n+2}\,O_5}$$

are bibasic alcohols corresponding to the type $\left.\begin{array}{l}\mathrm{(C_nH_{2n})_{m-1}}\\ \mathrm{H_2}\end{array}\right\}\mathrm{O_m}$.

Alcoholic series II.

$$\left.\begin{array}{lll} \mathrm{C_nH_{2n}O} & \text{allylic alcohols of the type} & \mathrm{C_n'H_{2n-1}\,H} \\ \mathrm{C_nH_{2n}O_2} & " \text{ glycols } " & \mathrm{C_n''H_{2n-2}\,H_2} \\ \mathrm{C_nH_{2n}O_3} & " \text{ glycerine } " & \mathrm{C_n'''H_{2n-3}\,H_3} \\ \vdots & & \end{array}\right\}\ \mathrm{O}$$

of this series the only member known as yet is allylic alcohol $\mathrm{C_3H_6O}$ corresponding to the general formula $\mathrm{C_nH_{2n}O}$.

Alcoholic series III. IV. V.

$\mathrm{C_nH_{2n-2}O}$, $\mathrm{C_nH_{2n-2}O_2}$, etc.
$\mathrm{C_nH_{2n-4}O}$, $\mathrm{C_nH_{2n-4}O_2}$, etc.
$\mathrm{C_nH_{2n-6}O}$ the homologues of phenylic alcohol;
$\mathrm{C_nH_{2n-8}O}$ " cinnamylic alcohol.

The homologous series answering the general formula $\mathrm{C_nH_{2n-6}O}$ is

$\mathrm{C_6H_6O}$	phenylic alcohol	boil. point,	184°.
$\mathrm{C_7H_8O}$	benzoylic "	" "	204°.
$\mathrm{C_8H_{10}O}$	xylenic "	" "	220°.
$\mathrm{C_9H_{12}O}$	?		
$\mathrm{C_{10}H_{14}O}$	cuminic "	" "	243°.

as homologous with phenylic alcohol, the last member of this series, cuminic alcohol, ought to boil at 264°.

Forming a hemilogous series out of such of those alcohols as answer to the general formula $\mathrm{C_nH_{n+1}O}$ we have:

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C_7H_8O benzoylic alcohol, boil. point, 204°.
$C_9H_{10}O$ cinnamylic " " " 250°.

the difference in composition is here $2CH$, the difference in boiling point, 46°; to the difference CH in composition there corresponds therefore a difference in the boiling points of 23°, and as to the difference CH_2 we mostly find a difference of 19°—20° in boiling points, the influence of the atom of H on the boiling point is in this case 3°. In a similar manner the influence of C on the boiling point may be shown to be 26°, as benzoylic alcohol and cinnamylic alcohol differ by $C+CH_2$ and CH_2 answers to 20°, we have 46°−20°=26°. The influence of the single elements on the boiling point may thus be found by seriation and general laws deduced by comparing the different results obtained by this method. The acids form quite a number of generic series.

Series of Acids I.

$C_nH_{2n}O_2$ fatty acids n=1 to n=30.
$C_nH_{2n}O_3$ glycolic acid n=2.
$C_nH_{2n}O_4$ glyceric acid n=3 (isomeric with lactic acid.)
⋮

The acids of this generic series correspond to the first alcoholic series.

Series of Acids II.

$C_nH_{2n-2}O_2$
$C_nH_{2n-2}O_3$
$C_nH_{2n-2}O_4$
$C_nH_{2n-2}O_5$
⋮

The special homologous series deriving from this generic series are,

$C_3H_4O_2$ acrylic acid.	$C_2H_2O_3$ glyoxylic acid.
$C_4H_6O_2$ crotonic "	$C_3H_4O_4$ pyroracemic acid.
$C_5H_8O_2$ angelic "	⋮
etc. etc.	
$C_2H_2O_4$ oxalic acid.	$C_3H_4O_5$ tartronic acid.
$C_3H_4O_4$ malonic "	$C_4H_6O_5$ malic "
$C_4H_6O_4$ succinic "	⋮
$C_5H_8O_4$ lipic "	
etc. etc.	
$C_4H_6O_6$ tartaric acid.	$C_6H_{10}O_8$ mucic acid.
⋮	

Series of Acids III.

$C_nH_{2n-4}O_2$
$C_nH_{2n-4}O_3$
$C_nH_{2n-4}O_4$
$C_nH_{2n-4}O_5$
⋮

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From this generic series are derived :—

$C_6H_8O_2$ sorbic acid.
$C_4H_4O_4$ maleinic acid.
$C_5H_6O_4$ itaconic "
$C_6H_8O_4$?
$C_7H_{10}O_4$ terebinic "

$C_3H_2O_5$ mesoxalic acid.
$C_6H_8O_7$ citric acid.

Acid series IV.

$C_nH_{2n-6}O_2$
$C_nH_{2n-6}O_3$
$C_nH_{2n-6}O_4$
$C_nH_{2n-6}O_5$
⋮

From this generic series we derive :—

$C_6H_6O_2$ oxyphenic acid.
$C_8H_{10}O_2$ terebentilic "

$C_5H_4O_3$ pyromucic acid.
$C_6H_6O_3$ pyrogallic "
$C_7H_8O_3$ ipecacuanic "
$C_8H_{10}O_3$ ricinoleic "

$C_4H_2O_4$ mellitic acid.
$C_3H_{10}O_4$ cholesteric "

$C_6H_6O_5$ aconitic acid.*

Acid series V.

$C_nH_{2n-8}O_2$
$CH_{2n-8}O_3$
$C_nH_{2n-8}O_4$
$C_nH_{2n-8}O_5$
⋮

From this generic series we derive :—

$C_7H_6O_2$ benzoic acid.
$C_8H_8O_2$ toluylic "
$C_9H_{10}O_2$?
$C_{10}H_{12}O_2$ cuminic "

$C_8H_8O_6$ phenoxacetic acid.

$C_5H_2O_5$ krokonic acid.
$C_6H_4O_5$ comenic "
$C_7H_6O_5$ gallic "
$C_{24}H_{40}O_5$ cholic "
$C_7H_6O_3$ salicilic acid.
$C_8H_8O_3$ anisic "
$C_9H_{10}O_3$ phloretinic acid.

* The radical of the tribasic aconitic acid $\left.\begin{matrix} C_6'''H_3O_3 \\ H_3 \end{matrix}\right\}O_3$ may be derived from a hydrocarburet by substitution of H_6 by O_3, as acetic acid is formed by substitution of H_2 by O in the radical C_2H_5. The triacid alcohol or glycerin corresponding to aconitic acid would therefore be $\left.\begin{matrix} C_6H_9 \\ H_3 \end{matrix}\right\}O_3$; it belongs to the alcoholic series II, answering to the general formula $C_nH_{2n}O_3$, and the type $\left.\begin{matrix} C_n'''H_{2n-3} \\ H_3 \end{matrix}\right\}O_3$. This remark applies, *mutatis mutandis*, to other acids.

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$C_8H_8O_4$ lecanoric acid. $C_9H_{10}O_4$ veratric acid.

Acid series VI.

$C_nH_{2n-10}O_2$
$C_nH_{2n-10}O_2$
$C_nH_{2n-10}O_2$
⋮

Of the acids deriving from this generic series only a few are known as yet.

$C_9H_8O_3$ cumaric acid. $C_7H_4O_7$ mionic acid.

$C_8H^6O_4$ phtalic acid.
$C_{24}H_{38}O_4$ choloidic "
$C_{25}H_{40}O_4$ hyocholic "

From other known acids it is hardly possible to form series, as they stand mostly isolated; there is for instance only one acid —anemonic acid $C_{15}H_{14}O_7$—known as yet, which corresponds with the general formula $C_nH_{2n-15}O_7$.

The generic series of acids considered above may be ranged into one primitive series:

$C_nH_{2n}O_{2x}$
$C_nH_{2n-2}O_{2x}$
$C_nH_{2n-4}O_{2x}$
$C_nH_{2n-6}O_{2x}$
$C_nH_{2n-8}O_{2x}$
$C_nH_{2n-10}O_{2x}$
⋮

where O_2^x means, that in order to form a generic series from one of these primitive formulas, O has successively to receive suffixed the numbers 2, 3, 4, ... *x*. It is easy to see that as every generic series, as for instance:

$C_nH_{2n-2}O_2$; $C_2H_2O_2$, $C_3H_4O_2$, $C_4H_6O_2$. . .
$C_nH_{2n-2}O_3$; $C_2H_2O_3$, $C_3H_4O_3$, $C_4H_6O_3$. . .
$C_nH_{2n-2}O_4$; $C_2H_2O_4$, $C_3H_4O_4$, $C_4H_6O_4$. . .
$C_nH_{2n-2}O_5$; $C_2H_2O_5$, $C_3H_4O_5$, $C_4H_6O_5$. . .
⋮

consists of two kinds of series, of which those lying on the horizontal lines are homologous series, and those lying on the vertical lines are series of oxydation, the primitive series therefore expresses a *seriation in a cube.*

It is worth observing that there may be series of isomeric substances running parallel to each other; such series may be called *homarithmical series.*

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ART. XI.—*Theoretical Determination of the Dimensions of Donati's Comet;* by Prof. W. A. NORTON.

(Continued from this Journal, vol. xxix, No. 87, p. 386.)

LET D= the perihelion distance of the comet, and V= the velocity at the perihelion; v = the velocity, θ_1 = the true anomaly, and r_1 = the radius-vector of the comet at any point of its orbit; and β = the inclination of tangent to orbit, to the radius-vector:

τ = the interval of time from assumed date to that of the perihelion passage of the comet:

k' = the acceleration due to the effective repulsion of the sun, expressed in fractional parts of a mile, at the perihelion distance of the comet:

R= the distance from the sun, and Θ_1 = the true parabolic anomaly of the cometary particle, at the instant of its leaving the sphere of influence of the nucleus:

V'= the initial velocity of the particle, in a direction parallel to the tangent to orbit of comet:

Φ = the angle included between the line R and the axis of the hyperbolic orbit of the particle; Δ= the angle included between this axis and the axis of the parabolic orbit of the nucleus; P= perihelion distance, p_2 = the half-parameter, e = the eccentricity, and A = the semi-transverse axis of the hyperbolic orbit; T= the interval of time from assumed date to the instant of the perihelion passage of the receding particle; ψ= the inclination of either asymptote to the axis:

θ = the true anomaly, and r = the radius-vector of the particle at any interval of time, t, after its perihelion passage:

γ = the angle included between the radius-vector of the particle and the axis of the comet's orbit.

Let a and c represent certain constants.

The intervals of time, τ, T, and t, are expressed in days and fractional parts of a day. The velocities V, V', and v, are expressed in miles and fractional parts of a mile, per second.

R and Θ_1 may be taken, with slight error, equal to the values of r_1 and θ_1, found for the same instant of time.

$$\tau = \frac{365^{d}\cdot 25}{3\pi\sqrt{2}} . D^{\frac{3}{2}}\left(\text{tang.}^{3}\frac{\theta_1}{2} + 3\ \text{tang.}\frac{\theta_1}{2}\right) \quad . \quad . \quad . \quad . \quad (10.)$$

$$r_1 = \frac{D}{\cos^2\frac{\theta_1}{2}}; \qquad V' = V\sqrt{\frac{D}{r_1}}; \qquad \beta = \frac{180^{\circ} - \theta_1}{2} \quad . \quad (11.)$$

$$\text{Let } D.k' = n; \quad n.\frac{D}{R} = n'; \quad \frac{V^2}{n} = m; \quad \frac{V'^2}{n'} = m' \quad . \quad . \quad (12.)$$

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(1.) For orbit of particle leaving comet at perihelion,

$$e=m+1;\ p_2=m.D;\ A=\frac{D}{m+2};\ P=D;\ \Phi=0;\ \cos\psi=\frac{1}{e} \quad (13.)$$

(2.) For orbit of particle leaving comet at any other point of its orbit,

$$\left.\begin{aligned} e&=\sqrt{m'\sin^2\beta(m'+2)+1};\ p_2=m'\sin^2\beta.R;\ P=\frac{p_2}{e-1};\\ A&=\frac{R}{m'+2}. \end{aligned}\right\} \quad (14.)$$

$$\cos\Phi=\frac{m'\sin^2\beta+1}{e} \quad (15.) \qquad T=c.\operatorname{tang}\left(\operatorname{arc}^\circ\frac{\operatorname{tang}\Phi}{a}\right) \quad (16.)$$

(3.) For position of particle in its orbit,

$$\operatorname{tang}\theta=a\left(\operatorname{arc}^\circ\operatorname{tang}\frac{t}{c}\right) \quad (17.) \qquad r=\frac{p_2}{e.\cos\theta-1} \quad (18.)$$

$$\cos\theta=\frac{1}{e}\left(\frac{p_2}{r}+1\right) \quad (19.)$$

$$\Delta=\Theta_1-\Phi \quad (20.) \qquad \gamma=\theta-\Delta \quad (21.)$$

If the particle is emitted after the perihelion passage, $\gamma=\theta+\Delta$.

For a particle describing a *hyperbola concave toward the sun*, equs. (13) to (19) become

$$e=m-1;\ \text{or}\ e=\sqrt{m'\sin^2\beta(m'-2)+1} \quad (22.)$$

$$A=\frac{R}{m'-2};\quad P=\frac{p_2}{e+1};\quad \cos\Phi=\frac{m'\sin^2\beta-1}{e} \quad (23.)$$

$$r=\frac{p_2}{e.\cos\theta+1};\quad \cos\theta=\frac{1}{e}\left(\frac{p_2}{r}-1\right) \quad (24.)$$

The true anomaly was calculated from the time, in this case, by an indirect method founded upon the law of areas, which admits of any desired degree of approximation. The calculation might also be made by means of Gauss' formulæ.

In the instance of a repelled particle, which describes an orbit convex toward the sun, the true anomaly was calculated directly by equ. (17). In this equation, and in equation (16) a and c are constants for the same hyperbolic orbit, but vary from one orbit to another, with the initial circumstances of motion, and the supposed intensity of the repulsive force. The laws of their variation are quite simple, so that their values having been found for one hyperbolic orbit they may be readily computed for any other. These constants having been determined, equ. (17) makes known the true anomaly of a receding particle, for the whole extent of the tail of the comet, with a liability to error not exceeding 2′, and generally much less than this.

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The values of r and γ having been found for the position of a particle at any instant of time, we may readily obtain the right ascension and declination of the particle at that instant.

The following equations serve to determine the position of the particle with respect to the axis of the orbit of the comet, and another axis perpendicular to this drawn through the position of the sun.

$$x = r\cos\gamma \quad . \quad . \quad . \quad (25.) \qquad y = r\sin\gamma \quad . \quad . \quad . \quad (26.)$$

The relative position of any two different particles may be obtained by the equs.

$$\text{tang } s = \frac{y-y', \text{ or } y'-y}{x-x', \text{ or } x'-x} \quad . \quad . \quad . \quad (27.) \qquad d = \frac{x-x', \text{ or } x'-x}{\cos s} \quad . \quad . \quad . \quad (28.)$$

in which s = the inclination of the line connecting the two parcles to the axis of the orbit, and d = the distance between the particles.

The same equations will make known the relative position of any particle and the nucleus, at the same instant of time, if x' and y' be taken to represent the coördinates of the nucleus.

The former part of this memoir, published in this Journal, vol. xxix, p. 383, together with the formulas just given, was prepared, and the greater portion of the results of computation now to be published, were obtained more than a year since. The results in question, so far as they relate to the theoretical dimensions of the tail of the comet, were communicated to the American Association for the Advancement of Science, at their last meeting (Aug. 1860). The publication, in this Journal, of the detail of the investigation, has been delayed until leisure could be obtained for a more extended discussion.

The general topic that will first be considered, from our theoretical point of view, is the Dimensions and Form of the Tail of the Comet. A similar numerical investigation will then be made relative to the envelopes of the head. An inquiry will afterwards be instituted into certain special facts and phenomena, with reference to which careful measurements were made by astronomical observers; and an approximate determination given of the period of rotation, and position of the axis of the nucleus. In the light of all the quantitative results obtained, we may perhaps be able to form an adequate conception of the physical processes of development through which the great comet of 1858 passed, as it swept with its "trailing garments" of light through our firmament. We may also obtain some notion of the probable nature of the forces in operation, whose general character is distinctly made out, and whose laws and limits of varying intensity are determined. It will be seen that while from the general conception of the repulsion of the nucleus, combined with that of the sun, each varying in intensity for different cometary particles between certain limits, we may deduce the observed

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form and dimensions of the train of the comet, as well as of the head, and derive the phenomena of the rise and gradual recess from the nucleus of successive envelopes, we have in a supposed rotation of the nucleus the probable cause of certain special phenomena observed, as the spiral form of the outline of each incipient envelope, the inclination of the first direction of the axis of the tail to the radius-vector produced, &c.

Dimensions and Form of the Train of Donati's Comet,—theoretically investigated, and compared with the results of observation.

We will first observe that if we adopt, for the moment, the prevailing notion that the matter of which the train is made up is directly expelled by the sun from a nebulous envelope surrounding the nucleus, the divergence of the lines of the sun's action tangent to this envelope on opposite sides must have been exceedingly small; since the greatest breadth of the observed envelope was only 40,000 miles, while its distance from the sun was 55,000,000 miles, or more. The breadth of the train, resulting from this divergence at the distance of 55,000,000 miles from the nucleus could not have exceeded 80,000 miles; whereas the actual breadth, at less distances than that, was several millions of miles. If we discard the idea of an envelope in a condition of permanent equilibrium about the nucleus, and take account, in accordance with the Dynamical Theory now under discussion, of the divergent velocities of the jets streaming up from the nucleus, on one side and the other of the radius-vector of the comet, we are still unprovided with a cause adequate to develop a train of the enormous breadth just stated. According to calculations that will be presented in another connection, the velocity in a direction perpendicular to the radius-vector, of any such jet cannot have exceeded $0^{m}30$ per second and was probably much less. If we suppose this lateral velocity to have obtained, in the instance of the jets inclined under the largest angle to the radius-vector, we find that at the distance of 10,000,000 miles from the nucleus the resulting breadth of the tail, is less than 800,000 miles, while the extreme breadth at that distance, as observed on Oct. 5th, was not less than $3\frac{1}{2}$ millions of miles.

I find, as a result of the detailed discussion I have undertaken, that the great determining cause of the wide lateral dispersion of the matter of the train, consists in an *inequality in the forces exerted by the sun upon different cometary particles.* The other two causes above specified coöperated with this. Upon this hypothetical basis numerous calculations have been made, with the formulæ already given (pp. 54 and 55), and tested by comparison with the results of observation. These calculations consist in

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determinations of the positions on Oct. $5^d{\cdot}0776$, (W. M. T.) of particles which emerged from the sphere of influence of the nucleus on several previous dates. To these particles were attributed various repulsive and attractive accelerations, due to the sun's action, between certain limits, and also various initial lateral velocities answering to different inclinations to the radius-vector, of the jets proceeding from the nucleus. It will be seen, when we come to investigate the form of envelope that should result from the combined repulsive actions of the nucleus and sun, that if we conceive the ratio of the efficient repulsions of the two bodies to be constant for all points of the nucleus from which the jets proceed, the maximum inclination of a jet to the radius-vector, which answers to the observed form of the cometary envelope, is about 19°; and that if this ratio be supposed to vary from one point of the surface of the nucleus to another, its law of variation, and that of the effective repulsion of the nucleus, must be such that the greatest lateral velocity of a receding particle is nearly the same as if the ratio in question remained constant, and the limiting angle were 19°. The initial lateral velocity of a jet of cometary matter, it is to be observed, increases with the intensity of the effective repulsion of the nucleus. In fact it appears from equation 9^a, given in the former part of this memoir, that it varies, for a given angle of emission, a, nearly as the square root of the effective repulsion, p.

The effective repulsive force by which a particle is urged away from the nucleus is the excess of the actual repulsion of the nucleus over its attraction. The same is true of the effective repulsive force of the sun. The actual repulsions must accordingly be distinguished from the efficient repulsive forces by which the particle is solicited. It is assumed, as a fundamental principle, in our investigations, that the *actual* repulsive actions of the sun and nucleus upon any particle vary simply by reason of some change in the condition of the particle; and therefore that the ratio of these actions must remain unalterably the same, through whatever range their actual intensities may be supposed to vary.

The elements of the orbit of Donati's comet employed in the calculations, were computed by Mr. Searle, of the Dudley Observatory, and are as follows:—Per. pass. Sept. $29^d{\cdot}7523$ W. M. T.; $\pi = 36°\ 12'\ 21''$; $\Omega = 165°\ 18'\ 46''$; $i = 116°\ 57'\ 46''$; $\varphi = 85°\ 21'\ 21''$; log. $q = 9{\cdot}762236$.

The process of calculation of the position at a given instant, of an individual particle supposed to have left the sphere of influence of the nucleus at a certain previous date, is as follows: Equs. (10) and (11) give the initial circumstances of motion of the particle. The computed value of V' is the initial velocity of the particle, resulting from the motion of the nucleus. This is in

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a direction parallel to the tangent to the parabolic orbit of the comet, which makes the angle β with the radius-vector. In case the particle is emitted from the nucleus in a direction inclined to the radius-vector it has a certain velocity imparted by the repulsion of the nucleus, relative to the radius-vector. This *lateral velocity*, as it may be termed, is calculated from equs. (7) and (8), and is added to the velocity V' already determined, or subtracted from it, according as the jet proceeds from the preceding or following side of the nucleus. The result is the initial velocity to be attributed to the particle. The particle having the initial, or projectile velocity, thus determined, is urged away from the nucleus into remote space by the repulsive force of the sun, and describes a hyperbolic orbit having the sun in its outer focus. If we supposed it to set out in this orbit at the instant of the perihelion passage of the comet, the sets of equs. (12) and (13) serve for the determination of the orbit; and equs. (17) and (18) make known the true anomaly and radius-vector of the particle in its orbit. If the particle be supposed to leave the nucleus either before or after the perihelion passage, equs. (14) (15) and (16) are employed together with (17 and (18). From equs. (20) and (21) we then obtain the value of γ. The values of r and γ having been determined, we readily calculate the geocentric right ascension and declination of the position of the particle.

The process of calculation for a particle moving under the influence of a diminished gravitation toward the sun, in a concave hyperbolic path, is essentially the same; equs. (22) to (24) now take the place of equs. (13) to (18); and the true anomaly of the particle is determined by an indirect method.

We will take for illustration the calculation of the position on Oct. $5^d{\cdot}0776$, W. M. T., of the particle which left the sphere of influence of the nucleus at the instant of the perihelion passage (Sept. $29^d{\cdot}7523$). We will suppose the particle to have been emitted from the nucleus toward the sun in the line of the radius-vector, and therefore to have had no lateral velocity, or in other words to have had an initial velocity, V, equal to the velocity of the nucleus in its orbit, and in the same direction. We will also take the effective repulsive force of the sun, $k'=1{\cdot}82$; the attraction of gravitation of the sun, at the same distance, being regarded as unity.

$$D=55{,}000{,}000^m;\quad V=35^m{\cdot}166;\quad \beta=90°.$$

$k'=\frac{1}{48{,}980}$ of a mile; $n=D.k'=1122{\cdot}907$. (The value of n, as first found, and used in the following calculations, is $1122{\cdot}95$).

$m=\frac{V^2}{n}=1{\cdot}101250$; $e=m+1=2{\cdot}101250$; $P=55{,}000{,}000^m$; $p_2=m.D=60{,}568{,}700$.

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tang $\theta = 0{\cdot}018965$ (arc° tang $\frac{t}{19{\cdot}67}$); and t = interval from Sept. $29^{d}{\cdot}752$ to Oct. $5^{d}{\cdot}0776 = 5^{d}{\cdot}325$. The calculation gives $\theta = 16°\ 1'\ 40''$.

$$r = \frac{60{,}568{,}700}{2{\cdot}10125 \cos 16°\ 1'\ 40'' - 1} = 59{,}406{,}100^{m}. \quad \gamma = \theta = 16°\ 1'\ 40''.$$

With these values of r and γ we obtain,

R. Asc. = 214° 1′ 10″; Dec. = 22° 23′ 0″ N.

As another example we will determine the position on Oct. $5^{d}{\cdot}0776$, of a particle which left the sphere of influence of the nucleus on Sept. $24^{d}{\cdot}360$, and was emitted from the nucleus on its preceding side, and under an angle to the radius-vector of 19°. This is the average limiting angle of emission, for the outer envelope, on Sept. 24th and Oct. 2d. We have $k = 1{\cdot}213$.

By equs. (10) and (11), $\theta_1 = 16°\ 50'$; $r_1 = 56{,}209{,}000^{m}$; $V = 34^{m}{\cdot}785$; $\beta = 81°\ 35'$. By equs. (7) and (8), (taking $k = 1 + 1{\cdot}213 = 2{\cdot}213$, and reducing from distance $55{,}000{,}000^{m}$ to $56{,}209{,}000^{m}$), $v' = 0^{m}{\cdot}254$. Thus initial velocity $= 34^{m}{\cdot}785 + 0^{m}{\cdot}254 = 35^{m}{\cdot}039$.

$$m' = \frac{V'^2}{n'} = 1{\cdot}676085; \quad m' \sin^2\beta = 1{\cdot}64009; \quad e = \sqrt{m' \sin^2\beta (m'+2) + 1}$$

$= 2{\cdot}65125$. By equ. (15) $\Phi = 5°\ 15'\ 30''$.

Equ. (16) becomes, $T = 24{\cdot}5174 \text{ tang}\left(\text{arc}° \frac{\text{tang } \Phi}{0{\cdot}023123}\right)$; whence $T = 1^{d}{\cdot}7061$.

Interval from Sept. $24^{d}{\cdot}360$ to Oct. $5^{d}{\cdot}0776 = 10^{d}{\cdot}7176$. $t = 10^{d}{\cdot}7176 - 1^{d}{\cdot}7061 = 9^{d}{\cdot}0115$.

Equ. (17) becomes, tang $\theta = 0{\cdot}023123 \left(\text{arc}° \text{ tang } \frac{t}{24{\cdot}5174}\right)$; whence $\theta = 25°\ 0'\ 55''$.

Log $p_2 = \log (m' \sin^2\beta . R) = 7{\cdot}9646743$; and by equ. (18), $r = 65{,}726{,}500^{m}$.

$\Delta = \Theta_1 - \Phi = 16°\ 50' - 5°\ 15'\ 30'' = 11°\ 34'\ 30''$; $\gamma = \theta - \Delta = 25°\ 0'\ 55'' - 11°\ 34'\ 30'' = 13°\ 26'\ 25''$.

These values of r and γ give

R. Asc. = 219° 14′ 40″; Dec. = 29° 4′ 20″ N.

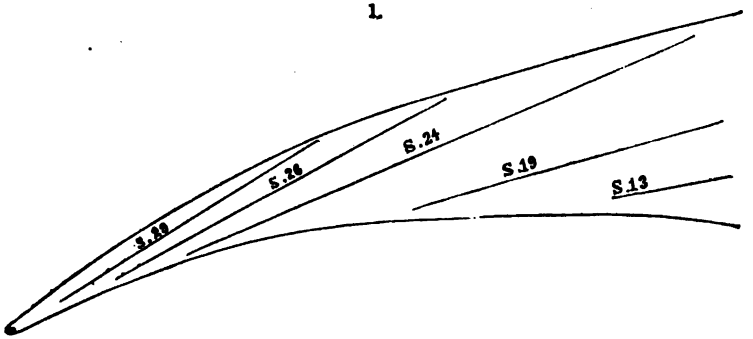
RESULTS.

The positions of particles have all been determined for Oct. $5^{d}{\cdot}0776$. The several dates at which they are supposed to have left the sphere of influence of the nucleus. are Oct. $2^{d}{\cdot}6043$, Sept. $29^{d}{\cdot}752$ (Per. pass.), Sept. $26^{d}{\cdot}9003$, Sept. $24^{d}{\cdot}360$, Sept. $19^{d}{\cdot}049$, and Sept. $13^{d}{\cdot}834$. The several values attributed to the intensity of the sun's effective force are as follows; for the repulsive force, 0, 0·455, 1·213, 1·82, and 2·73; for the attractive force, 0, 0·303, 0·455.

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On comparing *the calculated positions of particles which left the region of the nucleus at the same instant, and with the same initial velocity*, but were afterward subjected to different degrees of acceleration, from the action of the sun, it appears that they *are all distributed nearly along a right line, which if indefinitely produced would pass near the nucleus.* This result is illustrated in fig. 1; in which the lines traversing the tail in directions radiating from the nucleus represent the lines of particles that left the nucleus at the several dates above specified. When the calculated positions are plotted upon a large chart, the distribution is found to be very nearly rectilinear. The same fact appears on determining by calculation the relative positions of the several lines connecting the computed places of the particles in the plane of the orbit.

1.



The following table contains the computed coördinates of the positions of particles which left the region of the nucleus with

Part. leaves nucleus.	Force.	γ	r	R. Asc.	Dec.
D.		° ′ ″	M.		
Oct. 2·6043	R, 2·73	16 33 0	57,076,000		
" "	R, 1·213	16 35 6	56,728,500		
Sept. 29·7523	R, 1·82	16 1 40	59,406,000	214 1 10	22 23 0 N.
" "	R, 1·213	16 8 47	58,717,500		
" "	R, 0·455	16 17 50	57,802,600		
" "	R & A=0	16 23 30	57,329,000	212 45 40	20 38 20 N.
" "	A, 0·303	16 27 16	56,943,800	212 31 20	20 18 20 N.
" "	A, 0·455	16 28 30	56,836,800		
Sept. 24·360	R, 1·82	12 28 20	68,066,600	218 25 20	31 35 40 N.
" "	R, 1·213	13 15 0	65,638,700		
" "	R, 0·455	14 13 27	62,453,500		
" "	R & A=0	14 54 50	60,554,000	214 17 20	24 3 40 N.
" "	A, 0·455	15 39 10	58,579,500		
Sept. 19·049	R, 1·82	5 59 36	78,882,000	221 41 55	43 50 0 N.
" "	R & A=0	11 51 0	64,773,000	215 34 20	29 25 50 N.
" "	A, 0·303	13 8 13	62,238,000	214 32 40	26 36 5 N.
" "	A, 0·455	13 53 50	60,974,200		
Sept. 13·834	R & A=0	7 45 50	69,009,000	215 50 40	35 14 10 N.
" "	A, 0·303	10 7 10	65,303,000	214 53 0	30 56 50 N.
" "	A, 0·455	11 25 30	63,396,000	214 21 50	28 37 40 N.
Oct. 5 0776 (nucleus)		16 38 0	56,173,500	212 5 30	19 39 20 N.

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an initial velocity equal to that of the comet in its orbit. The values of γ and r in those instances in which the right ascension and declination are not given, were obtained by reduction from the determinations made on the supposition of the particles having at the outset certain lateral velocities imparted by the repulsion of the nucleus.

From the values of γ and r contained in the previous table, the results given in the following tables have been obtained. Column 2d gives the inclinations to the axis of the comet's orbit of the lines connecting the several particles with the particle for which the repulsion and attraction are each equal to zero. Column 3d contains the distances, in a direction perpendicular to the same axis, of these lines from the nucleus, expressed in miles. The next column contains the same distances expressed in minutes of arc. The sign +, in column 2d, shows that the line connecting the two particles recedes from the axis of the orbit, as it is produced toward the nucleus. The same sign in column 3d, shows that the line, if produced, would pass in advance of the nucleus.

Oct. 21·6043.			
Force.	Inclination.	Dist. in miles.	Dist. in min.
	° ′ ″	M.	′
R, 2·73	−10 54 30	+6,232	0·3
R, 1·213	−12 27 0	−8,800	0·4

Sept. 29·7523.			
Force.	Inclination.	Dist in miles.	Dist. in min.
	° ′ ″	M.	′
R, 1·82	−6 5 20	−26,500	1·4
R, 1·213	−6 9 30	−28,000	1·5
R, 0·455	−6 0 0	−24,600	1·3
A, 0·303	−7 1 50	−46,000	2·5
A, 0·455	−7 8 0	−48,300	2·6

Sept. 24·1360.			
For e.	Inclination.	Dist.	Dist.
	° ′ ″	M.	′
R, 1 82	+6 21 0	+27,840	1·5
R, 1·213	+5 44 10	−23,000	1·2
R, 0·455	+6 42 0	+49,790	2·7
A, 0·455	+5 58 20	− 4,000	0·2

Sept. 19·049.			
Force.	Inclination.	Dist.	Dist.
	° ′ ″	M.	′
R, 1·82	+18 35 10	+440,800	24·0
A, 0·303	+16 51 40	+121,000	6 6
A, 0·455	+17 43 40	+281,300	15·3

Sept. 13·834.			
Force.	Inclination.	Dist.	Dist.
	° ′ ″	M.	′
A, 0·303	+27 44 50	+900,000	49·
A, 0·455	+27 25 10	+762,000	41·

The following table shows the average inclinations of the lines connecting the several particles emitted at each date, with the particle for which the repulsion and attraction are each equal to zero; also the distances of the individual particles from the average lines of direction. When the distance is affected with a negative sign, the particle is found on the side of the line toward the axis of the orbit.

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	Average Inc.	Distance.					
		+R, 2·73	R, 1·82	R, 1·213	R, 0·455	A, 0·303	A, 0·455
D.	° ′ ″	′	′	′	′	′	′
Oct. 2·6043	−11 40 45	−0·25		+0·23			
Sept. 29·7523	− 6 29 0		−0·80	−0·43	−0·25	−0·21	−0·33
Sept. 24·360	+ 6 16 12		−0·63	+2 64	−0·84		−0·60
Sept. 19·049	+17 23 30		−18·0			−3·73	+1·42
Sept. 13·834	+27 35 0					+0·73	−1·11

These results show that all the cometary particles which may have been repelled from the nucleus in the line of the radius-vector, at any instant of time, and may have become widely separated by reason of the unequal repulsive actions of the sun upon the different particles, would be found distributed approximately along a right line directed toward the nucleus. If we consider a jet of cometary matter streaming out from the nucleus under an angle to the radius-vector, all of its particles, variously influenced by the sun, are found at the assumed date (Oct. 5^d·0776), distributed nearly along a line diverging somewhat from the line of the particles ejected at the same instant from the nucleus directly toward the sun. It lies in advance of the latter line in the case of a jet emanating from the preceding side of the nucleus, and behind it in the case of a jet proceeding from the following side. The entire collection of matter proceeding at any instant of time, from the various points of the side of the nucleus turned toward the sun, which lie in the plane of the orbit, accordingly forms, as it flows off into space, a band of nebulous matter, the sides of which are somewhat divergent, and the general direction of which is toward the nucleus. The entire train of the comet may be regarded as made up of a series of such bands of cometary matter which left the nucleus at various points of time anterior to the time of observation. Unless the ejection of matter was intermittent, these bands would be infinite in number, and overlap each other. If there were interruptions of continuity in the outflow of matter, they might become separately discernible.

The following are the calculated positions of particles which seem to accord most nearly with the position and form of the convex side of the train, as actually observed:

Left nucleus.		Oct. 2^d·6043.		Sept. 29^d·7523.		Sept. 26^d·9003.		Sept. 24^d·360.	
Force.	Lat. vel.	R. Asc.	Dec.	R. Asc.	Dec.	R. Asc.	Dec.	R. Asc.	Dec.
	M	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
R, 1·213	+0·255	212 28 20	20 2 50	213 39 50	21 44 0	215 26 40	24 58 20	217 14 40	29 4 20

The lateral velocity here assumed, answers to a jet emanating from the preceding side of the nucleus, under an angle of 19° to the radius-vector, (see p. 58).

The concave, or following side of the tail is best represented by the following calculated positions:

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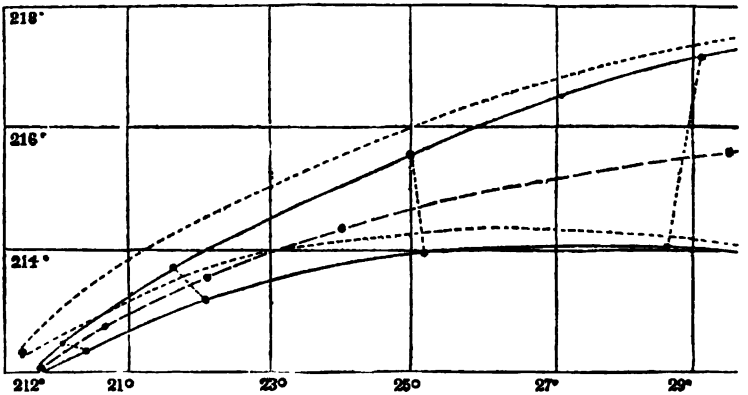
Left nucleus.		Sept. 29·7523.		Sept. 24·360.		Sept. 19·0490.		Sept. 13·634.	
Force.	Lat. vel.	R. Asc.	Dec.	R. Asc.	Dec.	R. Asc.	Dec	R. Asc.	Dec.
	M	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
A, 0·455	−0·184	212 24 50	20 16 40	213 9 50	22 8 0	213 52 10	25 9 20	214 5 20	28 37 50

It will be seen, in a subsequent part of the discussion, that the maximum lateral velocity for particles proceeding from the following side of the nucleus, and which may, because of the feebler repulsions they experience, be afterwards found at the concave side of the tail, cannot well exceed $0^m·18$; but may be less. In fact it would seem, without going into a detailed calculation, that the concave outline of the tail, for the extent of it under consideration, might be about as well represented by assuming a smaller initial lateral velocity and increasing somewhat the effective attractive force of the sun. I find, by estimation from the chart, that the limit of the solar attraction answering to a lateral velocity equal to zero, is about 0·61.

In a similar manner we find that the convex outline of the tail may, on the whole, be pretty well represented by discarding the supposed lateral velocity (0^m255) and augmenting the limit of the solar repulsion. The value of this limit thus obtained is about 1·5. It is important to observe, however, that at moderate distances from the nucleus the breadth of the train was much greater than these limits, with a lateral velocity equal to zero, give; and that the observed breadths at such distances afford indubitable evidence of the existence of considerable lateral velocities imparted, at the outset, by the action of the nucleus.

Fig. 2 will serve to illustrate the comparison of the tail thus theoretically determined with the tail as actually observed at the

2.



same date. The figure of the comet, with its train, which is farthest in advance, and whose outline is indicated by a dotted curve, represents the same in its actual position and dimensions,

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as carefully determined by Professor Bond, by collating and discussing a large number of European observations. It is reduced from a chart kindly furnished me by Prof. Bond. The full curve lying immediately behind, or below the other, runs through the foregoing calculated positions, and is accordingly the outline of the train, as theoretically determined. The portion of the train represented extends about $10\frac{1}{2}°$, or 10,000,000 miles from the nucleus. The scale of the diagram is too small to admit of anything like an accurate comparison between the two representations. We can only give the results of a comparison made by plotting the two upon a large chart.

The first fact to be observed is that the actual position of the nucleus on Oct. $5^d{\cdot}0776$ was $18''{\cdot}6$ in advance of the calculated position. (The latter is R. Asc. 212° 5′ 30″, Dec. 19° 39′ 20″ N. Mr. Searle's ephemeris of the comet gives, by interpolation, R. Asc., 212° 3′ 40″, Dec. 19° 39′ 11″ N.) The consequence is that the theoretical falls behind the actual train.

The following table gives the distances of the foregoing calculated positions of particles from the contiguous outline of the tail. The positions are all behind the observed outline.

Particle left nucleus.		Oct. $2^d{\cdot}6043$.	Sept. $29^d{\cdot}752$	Sept. $26^d{\cdot}900$	Sept. $24^d{\cdot}360$	Sept. $19^d{\cdot}049$	Sep. $13^d{\cdot}834$
Force.	Lat. vel.	Dist.	Dist.	Dist.	Dist.	Dist.	Dist.
	M.						
R, 1·213	+0·255	21′·2	25′·4	22′·8	7′·2		
A, 0·455	−0·184		18·6		25·4	18′·6	4′·7

The calculated positions are indicated by dots in the diagram. If they be taken in pairs, on opposite sides of the train, it will be seen that the lines connecting them are approximately perpendicular to its general direction. The lengths of these lines, or the approximate breadths of the train, at the several points, as compared with the lengths of the lines traversing the actual train, in parallel directions and at corresponding distances from the nucleus are given in the following table:

Particles left nucleus.	Oct. $2^d{\cdot}6$. and Sept. $29^d{\cdot}7$.	Sept. $29^d{\cdot}7$ and Sept. $24^d{\cdot}3$.	Sept. $26^d{\cdot}9$ and Sept. $19^d{\cdot}0$	Sept. $24^d{\cdot}3$. and Sept. $13^d{\cdot}8$.
Calculated lengths.	14′·5	37′·9	85′·8	168′·6
Actual lengths.	16·5	35·2	86·4	170·7

The distances were obtained by measurement from the chart, with a scale of equal parts, and are each approximately equal to the number of minutes in the arc connecting the pair of particles, or in the corresponding arc traversing the observed train.

The broken line lying nearly in the middle of the theoretical train, is traced through the positions occupied by the several particles which left the nucleus at the assumed dates and subse-

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quently continued on in the tangent to the orbit; it being supposed that they were subject to no effective action from the sun, whether repulsive or attractive. It accordingly appears that not far from *one-half of the tail, in breadth, on the concave side was made up of particles that were not effectively repelled by the sun, but separated from the nucleus, after having become disengaged from its influence, only because they gravitated toward the sun with less force than the nucleus did.* It will be seen, in the sequel, that these cometary particles, although subject to an effective attractive action from the sun, were in all probability expelled from the nucleus by a repulsive force, and on leaving its surface had no projectile velocity.

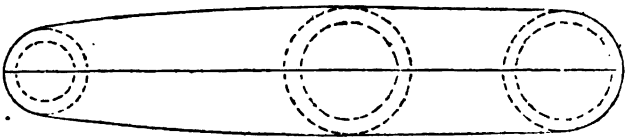
The calculations also show that, except in the immediate vicinity of the nucleus, the particles on the preceding side of the tail left the region of the nucleus several days later than those which are at the same distance from the nucleus on the concave side. For example, at the distance of about 10,000,000 miles we find on the convex side the particle which set out on Sept. $24^d{\cdot}360$, and on the concave side the particle which set out on Sept. $13^d{\cdot}834$.

It will be observed that the calculations hitherto made, have reference to the longitudinal section of the train by the plane of the orbit. All the cometary matter dispersed over this section proceeded originally from points on the exposed surface of the nucleus lying in the plane of the orbit. If we take into consideration the entire collection of matter proceeding from all parts of the surface of the nucleus lying circularly around the point nearest the sun, this, after it has been forced back past the nucleus by the repulsive energy of the sun, will have a conoidal form, with, as will hereafter be seen, a deficiency of matter toward the axis. Regarding it as a hollow conoid its cross section will be a circular ring, or band. On all sides of the conoidal stream will be found particles of matter subject to all the different varieties of solar action, between the two extreme limits, $R=1{\cdot}213$, and $A=0{\cdot}455$. The cross section will therefore be composed of as many different circular, or nearly circular rings, as there are different intensities of solar force in operation. These rings at first concentric, and possibly coincident, will separate as they move away from the nucleus, and will at the same time expand by reason of the velocity transverse to the radius-vector originally imparted to their constituent particles by the repulsion of the nucleus. The cross section of the tail of the comet at any supposed distance from the nucleus is accordingly made up of these expanded and separated circular rings; and its outline is the curve enveloping and touching them all. Fig. 3, represents the cross section at the distance of about 10,000,000 miles from the nucleus. Its longest diameter is in the plane of

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the orbit, and is about 3,600,000 miles. The extreme circular ring on the left, or preceding side, is made up of the particles

8.



which are repelled from the sun by the greatest force (1·213), and the extreme ring on the right is composed of particles which have been solicited by the greatest attractive force (0·455). The radius of the former is 236,000 miles, and that of the latter 338,000 miles. The middle circle is composed of particles which are neither attracted nor repelled; its radius is 348,000 miles. The mean breadth of the cross-section of the tail, at the distance supposed, as determined from these three circles, is 615,000 miles; and the ratio of the longest diameter to the mean breadth, is as 5·86 to 1.

We have already intimated (p. 64) that the initial lateral velocity of the particles that go to the extreme concave side of the tail, was probably less than $0^m{\cdot}184$, and may have been very small. The mean breadth of the cross section was therefore probably less than 615,000 miles. It may not have exceeded 360,000 miles.

At less distances from the nucleus the cross-section of the train, as determined upon the theory of a repulsion exerted by the nucleus, will deviate less from the circular form. At the very nucleus the cross section perpendicular to the radius-vector, must be almost an exact circle; unless the limiting angle of emission is different on different sides of that line.

These theoretical determinations accord with the results of observations made by Dr. Pape, of Altona, to determine the actual form of the cross-section of the tail at various points. He finds it to have been circular in the vicinity of the nucleus, and at points quite distant from the nucleus to have had a considerably greater extension in the plane of the orbit than in a direction perpendicular to that plane. Dr. Winnecke, of the Pulkova Observatory, in announcing these results deduced from the observations of Dr. Pape, remarks, "We are thus conducted to a remarkable figure of the tail; in the vicinity of the nucleus the transverse sections are circular in form, at greater distances therefrom curves considerably flattened, whose longest diameter probably lies in the plane of the orbit."

In what precedes we have taken account only of the outer envelope of the head of the comet, and of its indefinite prolongation in a continuous stream which we have regarded as the train.

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of the comet. But each of the several envelopes, lying in regular succession within the outer one, is upon the present theory, the round summit of a similar fountain of shining nebulous matter, which flows on continuously past the nucleus into the depths of space. These several conoidal streams lie, at first, one within the other, but at a distance from the nucleus must become more or less intermingled, unless each is composed of particles differently repelled, or attracted by the sun, from those of all the others. The entire luminous stream which we call the tail of the comet is made up of these individual streams equal in number to the number of separate envelopes.

This conception, which is a necessary consequence of the Dynamical Theory under discussion, accords with the notion to which Dr. Winnecke was conducted by his observations, with regard to the actual physical structure of the train of Donati's comet. He intimates that these observations can only be satisfied by the hypothesis of several conoidal trains enclosed one within the other.

It should be observed that in comparing the longitudinal section of the tail of the comet in the plane of the orbit, as theoretically determined, with the tail as actually observed, we have virtually assumed that the plane passing through the line of sight and the general direction of the tail was perpendicular to the plane of the orbit. In point of fact at the assumed date (Oct. $5^d{\cdot}0776$) the inclination of the two planes was about 60°. As a consequence the preceding outline of the visible tail would be a little in advance of the curve of intersection of the plane of the orbit with the preceding surface of the tail; and the following outline a little behind the curve of intersection with the following surface. The tendency of this cause is to diminish slightly the limits of the solar repulsion and attraction.

I propose now to show that *the cometary particles found on the following side of the tail, although subject to an effective, though diminished attraction from the sun, were in all probability expelled from the nucleus by a repulsive action*, after the same manner as those found on the preceding side, and effectively repelled by the sun. In the former portion of this memoir, we obtained the equation $H=\frac{pr}{k}$, or $\frac{H}{r}=\frac{p}{k}$; in which r denotes the radius of the nucleus, H the distance of the vertex of the envelope from the centre of the nucleus, p the *effective* repulsion of the nucleus, or the excess of its actual repulsion over its actual attraction, and k the actual repulsion of the sun. The true value of k is, then, the effective repulsive action of the sun, by which the particle is urged off into space in a hyperbolic orbit, augmented by the sun's attraction of gravitation. In considering

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the motion of a particle with respect to the nucleus we must regard it as subject to the actual rather than the effective repulsion of the sun, because both the particle and the nucleus must be considered as gravitating toward the sun. The value of k, for the particles of the outer envelope, is then $1{\cdot}213+1=2{\cdot}213$, or $0^{m}{\cdot}0000249$ per second. According to Professor Bond's measurements the greatest value of H may be taken at 14,000 miles, and r as 200 miles (it may possibly be less than this). Thus $p=70k=0^{m}{\cdot}0017430$. If now we regard the density of the solid nucleus as equal to that of the earth, the force of gravity at its surface will be equal to $27{\cdot}37\,A$; A denoting the sun's attraction of gravitation at the distance of the perihelion of the comet ($55{,}000{,}000^{m}$). Let R denote the greatest actual repulsion of the nucleus and a its actual attraction, both as exerted at the surface of the nucleus, then $p=R-a=R-27{\cdot}37\,A$; and, for the particles most energetically repelled, we have

$$\frac{R-a}{2{\cdot}213\,A}=\frac{p}{k}=\frac{H}{r}=70;\ \text{or}\ \frac{R-27{\cdot}37\,A}{2{\cdot}213\,A}=70.\quad\text{Thus}\ R=182{\cdot}28\,A.$$

Now, for the particles subject to the least actual repulsion from the sun, and to an effective attraction, $0{\cdot}455\,A$, as they move off in their hyperbolic orbits, and which as we have seen go to make up the following side of the tail, we must take $k=A-0{\cdot}455\,A=0{\cdot}545\,A$; and $\frac{2{\cdot}213\,A}{0{\cdot}545\,A}=4{\cdot}060$. For these particles we have $p'=R'-a$; and since we must suppose that the actual repulsive action of the nucleus will increase or decrease with the changing physical condition of the particle, in the same ratio as that of the sun, we shall have $R'=\frac{R}{4{\cdot}060}=\frac{182{\cdot}28\,A}{4{\cdot}060}=44{\cdot}9\,A$. Whence $p'=R'-a=44{\cdot}90\,A-27{\cdot}37\,A=17{\cdot}53\,A$. It thus appears that if we assume its density to be the same as that of the earth, the nucleus would still exert an effective repulsion upon the particles which gravitate toward the sun with the force $0{\cdot}455\,A$, and are found distributed along the following side of the train. If we suppose the density of the nucleus to be 1·75 instead of 1, we obtain for the value of p', $2{\cdot}05\,A$. But if it be assumed equal to twice the density of the earth, we get $p'=-3{\cdot}10\,A$. Thus upon this supposition the effective action of the nucleus becomes an attractive force, and hence the particles under consideration could not leave the nucleus.

It is to be observed that if p' comes out a feeble repulsive force, as in the case in which the density is taken equal to 1·75, the initial lateral velocity of the particles subject to its action must be much less than the velocity ($0^{m}{\cdot}184$) employed in our calculations for the concave side of the tail, and that if a smaller lateral velocity be adopted the observed form and position of the con-

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cave side cannot be represented without supposing the effective attraction of the sun to be greater than 0·455. But if this attraction be only increased to 0·500, we get $p' = -2{\cdot}1\,A$, and the particles therefore could not leave the nucleus. We may conclude therefore that the *mean density of the nucleus is in all probability less than* 1·75; the mean density of the earth being taken equal to unity.

If we attribute to the density of the nucleus decreasing values, less than unity, we obtain larger and larger positive values for p'; which however cannot possibly exceed $38\,A$. Upon every such supposition, therefore, there would be an effective repulsive force to expel the particles in question from the nucleus. But the idea here naturally suggests itself that the *limit to the solar attraction, for the concave side of the tail, may have been precisely that value which did not admit of any increase without converting the effective action of the nucleus into an attractive force.* If this plausible idea be admitted, we have for the limit in question the value answering to a lateral velocity equal to zero, which, as we have seen, is 0·61.

From this result we deduce for the probable density of the nucleus, 1·25. If the density be supposed greater than this, p' becomes an attractive force, and if it be taken materially less, p' is no longer the feeble repulsive force which the hypothesis of a limit resulting simply from the impossibility of the particles being repelled from the nucleus requires.*

From the calculations which have just been made we may gain some insight into the probable nature of the forces of repulsion exerted by the sun and nucleus upon cometary particles. We find that *the ratio of the actual repulsive forces exerted by the two bodies is not the same as that of their actual attractive forces.* Thus upon the supposition that the density of the nucleus is equal to that of the earth, the ratio of the attractive forces at the surface of the nucleus, is 27·37, while the ratio of the repulsive forces is equal to $\frac{182{\cdot}28\,A}{2{\cdot}213\,A}$, or 82·4. We obtain similar results, if we attribute other values to the density, as will be seen from the comparison made in the following table.

Density.	Ratio of Attr.	Ratio of Rep.	Density.	Ratio of Attr.	Ratio of Rep.
1	27	82	0·75	20	79
1·75	48	92	0·50	14	76
2	55	95	0·25	7	73
3	82	107	0·10	2·7	71

* In effecting this determination of the density it is tacitly supposed that the effective repulsion of the nucleus becomes changed into an attraction for the particles that would be ejected in the direct line toward the sun. If, as we shall hereafter see there is reason to believe, this change should occur only for the particles emitted under an angle to the radius-vector, and because of a diminution in the actual repulsions of the nucleus and sun as this angle becomes greater, the above determination of density (1·25) must be discarded.

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The two ratios approach equality as the assumed density is greater, but they cannot become equal however great the density may be supposed to be. On the other hand however small the density may be taken, and consequently also the ratio of the attractive forces, the ratio of the actual repulsions cannot be less than 70. Now the ratio of the actual attractive forces exerted by the two bodies is the same as that of their masses, the ratio of the repulsions is then greater than that of the masses. We may hence conclude that *the repulsion exerted by the sun, and also by the nucleus, is not a property belonging to all the particles of the mass*, like the attraction of gravitation. It is probable therefore, that it is either a magnetic, or an electric force, emanating from the surface of the body, or from a portion only of its mass.

Yale College, May 10th, 1861.

(*To be continued.*)

ART. XII.—*The Great Auroral Exhibition of Aug. 28th to Sept. 4th*, 1859.—7TH ARTICLE; by ELIAS LOOMIS, Professor of Natural Philosophy and Astronomy in Yale College.

SINCE the publication of my last auroral article I have obtained some additional information, chiefly collected during a recent visit to Europe.

1. *Observations at Highland, Illinois*, (lat. 38° 43′, long. 89° 48′ W.), *by* A. F. BANDELIER, Jr.

At 9 P. M. Aug. 28, 1859, I was struck by the appearance of a broad purple ray extending lengthwise across the seven stars of Ursa Major to 80° of height. This ray remained for about half an hour, rapidly changing. Then appeared three rays in the east inclining to the south, which ascended from a bright yellow circle resting upon a segment of a brown misty appearance. Both arch and segment were gradually rising, the former illuminated as by the faint lightning of a distant tempest. The segment greatly agitated near its upper border, tossing and rolling its cloudy particles over each other in heavy undulations. No more rays appeared, but the yellow arch and the segment rose slowly. Through the latter I saw plainly α Aurigae rise without much diminution of brightness.

At 1 o'clock a quantity of rays shot upwards from the lucid arch, purple at the base and middle, brilliant yellow at the top. A little S.E. from the zenith they united, forming a small semicircle of the most dazzling beauty, from which rays now shot downwards. The corona lasted only a few minutes, then broke up and vanished. Some rays continued after it, but the great movement of the arch and segment ceased gradually.

At 4 A. M. both still stood on the northern horizon. The greatest height of the arch during the whole apparition was 60°, that of the segment was 20° to 25°.

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Sept. 2d at 9 P. M. I observed a dark segment in the north looking very much like a fog, of an irregular circular form, the upper borders broken up, and 5° or 6° above the horizon at its greatest elevation. Behind it a faint light broke out, not unlike a distant prairie fire. The whole ranged from 10° west to 40° east. At $9^h\ 20^m$ four rays darted out directly north. They were of a pale milky color. They seemed to descend into the segment below, and then suddenly prolonged themselves into the true ray or flame. The same lightning-like illumination of the arch was visible as in the aurora of Aug. 28th.

At $9^h\ 30^m$ a strong ray appeared N. 20° E.

At $9^h\ 35^m$ light diminishing east.

At $9^h\ 45^m$ strong decrease. Segment almost without motion; its borders were now completely regular; continued to decrease and fall below the horizon.

At $10^h\ 30^m$ only feebly visible.

At $11^h\ 2^m$ segment only a small stripe of 2° in breadth, a faint lighted border.

At $3^h\ 30^m$ A. M. all had entirely vanished. Clouds were gathering from the south.

2. *Observations at Greenwich, England,* (lat. 51° 28′), *communicated by* Prof. G. B. Airy, Astronomer Royal of Great Britain.

Greenwich mean time.	Western declination.	Greenwich mean time.	Horizontal force.	Greenwich mean time.	Vertical force.
h m	° ′ ″	h m		h m	
August 28th.		August 28th.		August 28th.	
0 0	21 31 30	0 0	·0897	0 0	·02143
5 28	21 15 30	2 15	·0953	3 15	·02170
8 15	21 17 15	3 30	·0890	6 40	·01969
11 15	21 52 10	5 0	·0926	9 4	·01880
11 20	20 57 30	5 25	·0935	10 39	·02019
11 38	21 52 10	7 45	·0904	11 46	·01510
12 46	20 47 10	8 19	·0897	12 37	·00260
14 4	21 53 5	9 15	·0916	13 2	·01561
14 45	21 16 50	9 51	·0929	13 21	·00263
16 5	22 1 50	21 0	·0832	14 9	·01836
17 11	21 3 0			14 27	·01340
18 9	21 28 30			16 49	·02263
18 55	21 5 30			18 10	·00840
19 6	21 55 40			22 6	·02251
21 15	21 4 10			22 43	·02120
August 29th.		August 29th.		August 29th.	
0 0	21 34 10	0 0	·0845	0 0	·02143
2 39	21 27 10	3 13	·0933	2 30	·01989
5 28	21 7 10	3 50	·0958	5 10	·01556
5 50	21 24 20	4 9	·0809	5 26	·01580
7 20	21 16 30	5 30	·0895	7 22	·01352
14 26	28 0	18 27	·0865	12 28	·01464
19 46	12 0	19 39	·0832	14 58	·01654
23 45	29 30	21 56	·0844	19 20	·02229
August 30th.		August 30th.		August 30th.	
0 0	21 28 20	0 0	·0861	0 0	·01882
5 20	20 25	2 39	·0886	9 18	·01349
12 52	27 50	7 45	·0880	18 47	·01963
19 3	15 0	14 14	·0893	23 15	·01730
21 37	20 30	21 45	·0854	23 59	·01481

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Table continued.

Greenwich mean time.	Western declination.	Greenwich mean time.	Horizontal force.	Greenwich mean time.	Vertical force.
h m	° ′ ″	h m		h m	
August 31st.		August 31st.		August 31st.	
0 0	21 46 10	0 0	·0867	0 0	·01481
7 6	18 40	7 18	·0900	5 15	·00950
9 22	9 30	9 20	·0909	16 40	·01563
14 10	23 40	12 45	·0883	17 30	·00301
16 17	22 5 20	15 53	·0930	17 45	·04158
19 45	20 57 45	18 47	·0889	17 56	·02297
20 12	20 31 10	19 30	·1027	18 20	·04261
20 14	21 7 10	20 10	·0763	18 30	·02722
20 16	20 55 10	20 15	·0940	18 41	·04139
20 18	21 22 20	20 41	·0841	19 6	·02228
20 24	20 56 25	20 50	·0938	19 15	·02817
20 27	21 24 10	21 19	·0787	20 15	·02031
21 40	21 1 30	21 44	·0947	20 33	·02166
22 10	21 26 10	22 15	·0777	21 37	·02097
22 42	21 10 0	23 10	·0888	23 20	·01730
September 1st.		September 1st.		September 1st.	
0 0	21 33 35	0 0	·0885	0 0	·01719
1 56	42 35	1 57	·0906	8 33	·01051
8 20	15 0	4 28	·0885	21 0	·01658
14 10	25 35	9 21	·0900	23 30	·01563
20 0	12 30	13 0	·0905	23 43	·01433
23 42	35 40	20 55	·0873	23 56	·02043
23 54	8 45	22 40	·0869		
September 2d.		September 2d.		September 2d.	
0 0	21 18 0	0 0	·0940	0 0	·01978
0 16	4 10	1 33	·1069	1 22	·02556
1 4	53 10	1 39	·0817	1 36	·01963
1 13	11 5	1 59	·1065	1 53	·02437
1 18	52 15	2 27	·0778	2 17	·02197
1 40	21 10	2 52	·1120	2 48	·02769
1 54	58 50	3 23	·1003	3 13	·02203
2 13	11 15	3 37	·1078	3 30	·02400
2 30	51 40	5 43	·0930	5 47	·01988
2 43	13 10	6 30	·0964	6 3	·02142
3 40	51 25	8 40	·0850	8 37	·01602
3 57	23 10	9 25	·0937	9 5	·01670
5 50	40 0	11 29	·0802	10 47	·01200
6 15	0 30	12 43	·0945	11 17	·01329
7 0	24 10	12 54	·0816	11 32	·01063
8 51	20 53 0	14 48	·0884	12 37	·01293
9 40	21 32 0	16 13	·0816	12 56	·01142
11 4	21 6 25	18 25	·0848	14 40	·01290
11 43	21 42 20	21 35	·0812	14 57	·01221
14 15	21 5 30	23 12	·0833	15 50	·01320
15 52	27 20			16 6	·01281
20 15	15 30			18 48	·01556
September 3d.		September 3d.		September 3d.	
0 12	21 27 20	0 0	·0889	0 0	·01789
3 3	58 45	0 31	·0940	3 30	·01620
5 53	21 10	3 15	·0837	4 40	·01946
6 12	20 50 5	5 9	·1075	5 32	·01683
6 53	21 28 15	6 27	·0887	6 4	·01936
7 30	0 30	6 31	·0930	6 58	·01300

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Table continued.

Greenwich mean time.	Western declination.	Greenwich mean time.	Horizontal force.	Greenwich mean time.	Vertical force.
h m	° ′ ″	h m		h m	
September 3d.		September 3d.		September 3d.	
7 56	21 28 30	8 5	·0835	7 26	·01495
8 15	11 30	10 44	·0891	8 4	·01347
11 50	26 0	12 39	·0811	8 15	·01425
13 8	15 10	13 45	·0850	12 35	·00900
16 7	25 0	15 15	·0822	15 7	·01510
21 6	13 0	19 21	·0861	19 36	·01922
September 4th.		September 4th.		September 4th.	
0 0	21 33 0	0 0	·0830	0 0	·01809
1 20	41 45	2 15	·0936	2 4	·01763
2 37	22 30	3 22	·0845	2 36	·01846
3 30	30 20	3 52	·0912	3 37	·01682
10 54	12 10	5 19	·0837	3 56	·01701
12 4	30 30	12 55	·0877	14 4	·01102
19 23	3 30	13 54	·0827	21 53	·01732
23 15	37 10	19 32	·0883	23 59	·01739
		23 12	·0790		

3. *Deflections of the needles of the Vertical Galvanometers of Cooke and Wheatstone's Telegraph instruments, observed at Ramsgate Station in the County of Kent, England, upon three distinct lines of telegraph: namely, Ashford and Margate, distant in a direct line 27½ miles; Ashford and Ramsgate, distant 27½ miles; Ramsgate and Margate, 3 miles;* furnished by Mr. Charles V. Walker.

Note.—The direction in which the current moves is indicated by the letters N and S; N means that the current is from the more northerly to the more southerly station of the two; S means the reverse. The direction of Ashford from Ramsgate is S. 80° W., and that of Margate from Ramsgate N. 22° W.

In the "value column," "strong" means 30° or 40°; "hard over," 45°; horizontal from 70° to 80°. Ordinary strong telegraph signals produce about 60°.

Date.	Time.		Telegraph Line.	Direction.	Value.
1859.					
Aug. 29th	7·10 A. M.	7·25 A. M.	Ashford and Margate,	S	Strong.
"	7·36 "	7·45 "	" " "	S	Hard over.
"	7·46 "	7·49 "	" " Ramsgate,	N	Strong.
"	7·50 "	8· 0 "	" " "	S	Hard over.
"	9·45 "	10· 0 "	" " "	N	" "
"	10·20 "	10·27 "	" " "	N	Strong.
"	10·27 "	10·28 "	" " "	S	Hard over.
"	10·28 "	10·36 "	" " "	N	Strong.
"	10·37 "	10·40 "	" " "	S	Hard over.
"	10·40 "	10·45 "	" " Margate,	N	" "
"	10·45 "	10·49 "	Margate and Ashford,	S	" "
"	10·50 "	10·53 "	" " "	N	" "
"	10·53 "	11· 0 "	" " "	S	Horizontal.
"	11· 2 "	11·25 "	" " "	N	"
"	11·25 "	11·40 "	" " "	N	Hard over.
"	11·45 "	12·20 P. M.	" " "	N	" "
"	12·30 P. M.	12·45 "	" " "	N	Strong.
"	12·48 "	1· 3 "	" " "	N	"
"	1· 5 "	1·40 "	" " "	S	"

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Table continued.

Date.	Time.		Telegraph Line.	Direction.	Value.
1859.					
Aug. 20th	2·40 P. M.	2·53 P. M.	Margate and Ashford,	N	Very Strong.
"	3·40 "	3·50 "	" " "	N	" "
"	3·52 "	4· 5 "	" " "	S	Horizontal.
"	3·52 "	4· 5 "	Ashford and Ramsgate,	S	Very strong.
"	4·15 "	4·50 "	" " Margate,	N	" "
"	5· 0 "	5·20 "	" " "	N	" "
"	" "	" "	" " Ramsgate,	N	" "
"	5·25 "	5·48 "	" " Margate,	N	" "
"	6·10 "	6·23 "	" " "	S	" "
"	6·50 "	7·20 "	" " "	S	" "
"	7·53 "	8·10 "	" " "	S	Slight.
Sept. 1st	11·20 A. M.	11·26 A. M.	" " "	S	Strong.
"	11·28 "	11·35 "	" " "	N	Slight.
Sept. 2d	7·10 "	7·42 "	" " "	N	Horizontal.
"	7·10 "	7·50 "	Ramsgate and Margate,	N	"
"	7·10 "	7·42 "	Ashford and Ramsgate,	N	"
"	7·43 "	7·48 "	" " Margate,	S	Strong.
"	" "	" "	" " Ramsgate,	S	"
"	7·49 "	7·51 "	" " Margate,	N	Hard over.
"	" "	" "	" " Ramsgate,	N	" "
"	7·51 "	7·56 "	" " Margate,	S	" "
"	" "	" "	" " Ramsgate,	S	" "
"	7·56 "	8· 0 "	" " Margate,	N	" "
"	" "	" "	" " Ramsgate,	N	" "
"	" "	" "	Ramsgate and Margate,	N	" "
"	8· 0 "	8· 7 "	Ashford and "	S	Strong.
"	" "	" "	" " Ramsgate,	S	"
"	" "	" "	Ramsgate and Margate,	S	"
"	8· 8 "	8·12 "	Ashford and "	S	"
"	" "	" "	" " Ramsgate,	S	"
"	" "	8·17 "	Ramsgate and Margate,	S	"
"	8·12 "	" "	Ashford and Ramsgate,	S	Hard over.
"	" "	" "	" " Margate,	S	" "
"	8·20 "	8·30 "	" " Ramsgate,	N	" "
"	" "	" "	" " Margate,	N	" "
"	8·31 "	8·46 "	" " "	S	" "
"	" "	8·40 "	" " Ramsgate,	S	" "
"	8·41 "	8·46 "	" " "	N	" "
"	" "	" "	" " Margate,	N	" "
"	8·47 "	8·54 "	" " "	S	" "
"	" "	" "	" " Ramsgate,	S	" "
"	8·54 "	9· 0 "	" " "	N	Strong.
"	" "	" "	" " Margate,	N	"
"	9·22 "	9·25 "	" " "	N	"
"	9·26 "	9·28 "	" " "	S	"
"	9·29 "	9·40 "	" " "	N	"
"	9·40 "	9·52 "	" " "	S	"
"	9·55 "	10·32 "	" " "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	10·35 "	10·38 "	" " Margate,	S	"
"	10·38 "	10·40 "	" " "	N	"
"	10·41 "	10·46 "	" " "	S	"
"	10·55 "	11· 0 "	" " "	S	"
"	11· 2 "	11·15 "	" " "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	11·16 "	11·27 "	" " Margate,	S	"
"	11·20 "	11·32 "	" " Ramsgate,	S	"
"	11·38 "	11·40 "	" " Margate,	N	"
"	11·40 "	11·45 "	" " "	S	"
"	11·45 "	11·49 "	" " "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	" "	11·50 "	Ramsgate and Margate,	N	"
"	11·50 "	11·51 "	Ashford and "	S	"
"	" "	" "	" " Ramsgate,	S	"
"	" "	" "	Ramsgate and Margate,	S	"
"	11·52 "	11·54 "	Ashford and Ramsgate,	N	"

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Table continued.

Date.	Time.		Telegraph line.	Direction.	Value.
1859.					
Sept. 2d	11·52 A. M.	11·54 A. M.	Ramsgate and Margate,	N	Strong.
"	" "	" "	Ashford and "	N	"
"	11·59 "	12· 3 P. M.	" " Ramsgate,	N	"
"	" "	" "	" " Margate,	N	"
"	" "	" "	Ramsgate and "	N	"
"	12· 4 P. M.	12·14 "	Ashford and Ramsgate,	S	Horizontal.
"	" "	" "	" " Margate,	S	Strong.
"	12·15 "	12·30 "	" " "	N	Horizontal.
"	" "	" "	" " Ramsgate,	N	Strong.
"	12·30 "	12·35 "	" " Margate,	N	"
"	" "	" "	" " Ramsgate,	N	"
"	" "	" "	Ramsgate and Margate,	N	"
"	12·36 "	12·57 "	Ashford and "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	12·57 "	1·18 "	" " Margate,	S	"
"	" "	" "	" " Ramsgate,	S	"
"	" "	" "	Ramsgate and Margate,	S	"
"	1·20 "	1·44 "	Ashford and "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	" "	" "	Ramsgate and Margate,	N	"
"	1·44 "	1·47 "	Ashford and Ramsgate,	S	"
"	" "	" "	" " Margate,	S	"
"	1·47 "	1·54 "	" " "	N	"
"	" "	" "	" " Ramsgate,	N	"
"	2· 0 "	2·15 "	" " Margate,	N	"
"	" "	" "	" " Ramsgate,	N	"
"	2·15 "	2·18 "	" " Margate,	S	"
"	" "	" "	" " Ramsgate,	S	"
"	2·21 "	2·31 "	" " Margate,	S	Horizontal.
"	" "	2·37 "	" " Ramsgate,	S	"
"	2·38 "	2·52 "	Ramsgate and Margate,	N	Strong.
"	" "	" "	Ashford and Ramsgate,	N	"
"	" "	" "	" " Margate,	N	"
"	2·52 "	2·55 "	Ramsgate and "	S	"
"	" "	" "	Ashford and Ramsgate,	S	"
"	" "	" "	" " Margate,	S	"
"	2·55 "	3· 2 "	Ramsgate and "	N	"
"	" "	" "	Ashford and Ramsgate,	N	"
"	" "	" "	" " Margate,	N	"

4. *Auroral observations made at Sea; furnished by* Rear-Admiral Robert Fitz Roy, of the British Navy.

A. Lat. 50° 47′ N., long. 10° 12′ W.

Aug 28th. About $11^h\ 30^m$ P. M. the sky being cloudy, it brightened up like daybreak, remained so for twenty minutes, then turned a dark red, and soon after darkened in again as before.

B. Lat. 29° 48′ N., long. 45° 20′ W.

Aug. 28th. The aurora seen from 9 P. M. till 4 A. M. the next morning, of a rose color. Streamers about 30° high.

C. Lat. 26° 48′ N., long. 45° 40′ W.

Aug. 28th. Sky in the S.S.E. of a lurid fiery color; a vivid bright streak from the middle.

D. Lat. 25° 45′ N., long. 27° 4′ W.

Aug. 28th. From $11^h\ 15^m$ P. M. till midnight the N.W. portion of the sky of a deep red color, resembling an angry sunrise.

E. Lat. 33° 55′ N., long. 44° 13′ W.

Sept. 2d. The aurora faintly visible in the north about 4 A. M.

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F. Lat. 33° 33′ N., long. 33° 2′ W..

Sept. 2d. At 3 A. M. a low bank of straw colored aurora on the northern horizon; it became a beautiful rose color, covering about four-tenths of the sky and gradually disappeared as the day broke.

G. Lat. 24° 10′ N., long. 35° 50′ W.

Sept. 2d. Aurora seen in the morning from N.W. to E.N.E. of a bright red color, interspersed with streaks of white, converging to a center nearly over the ship.

5. *State of the weather at the Russian magnetic observatories, during the Auroral display of Aug.* 28*th to Sept.* 2*d*, 1859; *furnished by* A. T. KUPFFER, Director of the Central Physical Observatory.

Hour.	St. Petersburg.	Catherinburg.	Barnaoul.	Nertchinsk.
		August 28th, 1859.		
0	overcast	cloudy	scat. clouds	overcast
1	overcast	overcast	scat. clouds	overcast
2	cloudy	overcast	scat. clouds	overcast
3	cloudy	overcast	scat. clouds	overcast
4	cloudy	cloudy	scat. clouds	overcast
5	cloudy	cloudy	clouds in hor'n	overcast
6	cloudy	cloudy	clouds in hor'n	overcast
7	cloudy	cloudy	clouds in hor'n	clouds in hor'n
8	cloudy	cloudy	clear	clouds in hor'n
9	cloudy	cloudy	clear	cloudy
10	light clouds	cloudy	clear	cloudy
11	light clouds	clouds in hor'n	clear	cloudy
12	light clouds	clear	clear	cloudy
13	cloudy	clear	clear	overcast
14	cloudy	clear	clear	overcast
15	cloudy	clear	clear	overcast
16	cloudy	clear	clouds in hor'n	overcast
17	cloudy	clouds in hor'n	clouds in hor'n	overcast
18	cloudy	clouds in hor'n	clouds in hor'n	overcast
19	cloudy	clouds in hor'n	clouds in hor'n	overcast
20	cloudy	clouds in hor'n	clouds in hor'n	clouds in hor'n
21	cloudy	cloudy	scat. clouds	clouds in hor'n
22	cloudy	cloudy	scat. clouds	cloudy
23	cloudy	cloudy	scat. clouds	cloudy
		September 2d, 1859.		
0	scat. clouds	cloudy	cloudy	cloudy
1	scat. clouds	cloudy	scat. clouds	cloudy
2	scat. clouds	cloudy	cloudy	cloudy
3	light clouds	cloudy	cloudy	overcast
4	light clouds	cloudy	cloudy	cloudy
5	light clouds	cloudy	cloudy	overcast
6	light clouds	cloudy	cloudy	overcast
7	light clouds	clouds in hor'n	cloudy	cloudy
8	scat. clouds	clouds in hor'n	cloudy	clouds in hor'n
9	scat. clouds	clouds in hor'n	cloudy	clear
10	light clouds	cloudy	cloudy	clear
11	scat. clouds	cloudy	cloudy	clouds in hor'n
12	scat. clouds	clouds in hor'n	scat. clouds	clouds in hor'n
13	scat. clouds	clouds in hor'n	scat. clouds	clouds in hor'n
14	scat. clouds	clouds in hor'n	clouds in hor'n	clouds in hor'n
15	scat. clouds	clouds in hor'n	clouds in hor'n	clouds in hor'n
16	scat. clouds	clouds in hor'n	clouds in hor'n	clouds in hor'n
17	light clouds	clouds in hor'n	clouds in hor'n	cloudy
18	light clouds	clouds in hor'n	scat. clouds	cloudy
19	light clouds	clouds in hor'n	scat. clouds	cloudy
20	light clouds	clouds in hor'n	scat. clouds	overcast
21	light clouds	scat. clouds	scat. clouds	overcast
22	light clouds	cloudy	scat. clouds	cloudy
23	light clouds	cloudy	scat. clouds	overcast

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In vol. xxx, pp. 80–82, of this Journal, observations are published showing an unusual disturbance of the magnetic instruments throughout the whole of the Russian empire, but no mention is made of any aurora. The preceding observations show that during this period the sky was generally overcast at each of the Russian stations.

6. *Observations of the Aurora of Aug. 28th and 29th, 1859, made in Australia; furnished by* Mr. JAMES GLAISHER, of the Greenwich Observatory.

A. Observations at Hobarton, lat. 42° 52′ S., long. 147° 27′ E.

Aug. 29th, from $6^h\ 55^m$ to $7^h\ 25^m$ P. M. there appeared a most brilliant aurora extending from W. by N. to the eastern part of the horizon in one continuous arc of about 190°, and shooting up to the zenith. The eastern and western extremities of the conoid were of a pale ruby and deep red color, intermixed through the whole vault with bands of pale yellow and shades of dark and light green, and with here and there a small dark cloud jutting in; elsewhere the circumpolar stars glittered like diamonds set in an emerald and ruby ground. The phenomenon had for 30 minutes a most magnificent appearance, the bands being in complete repose, forming a truncated cone of glory, the apex of which, if projected, would have terminated in the zenith. This brilliant storm appeared again about $9^h\ 30^m$ P. M., flickering in brisk coruscations of most beautiful color from the horizon to the zenith.

A second display of the aurora appeared on the night of Sept. 2d, equally brilliant and extensive and less transitory. From midnight to 1 A. M. the aurora broke out into flickering streamers and coruscations, forming in the zenith a well defined corona, which shortly after became diffused and then dispersed.

B. Observations at Cape Otway, lat. 30° 51′ S., long 143° 50′ E.

Aug. 29th. Aurora most magnificent at $6^h\ 30^m$ P. M. and continued visible until after 2 A. M., displaying itself in the form of a rainbow, the arc extending to about 60° or 70°. First color above the horizon a light blue with a tint of green, blending into second, a very light yellow, again blending into third, a deep red.

C. Observations at Portland, lat. 38° 20′ S., long. 141° 55′ E.

Aug. 29th. Aurora visible at $6^h\ 40^m$ P. M. At 7 P. M. a bright band partly tinged with blue and pink, extending E. and W., pink rays converging to a centre on the band a little to the W. of the Milky Way. Gradually faded, and all disappeared by 8 P. M.

D. Observations at Melbourne Observatory, lat. 37° 49′ S., long 145° 9′ E., by GEORGE NEUMEYER.

On the evening of Aug. 28th great disturbances made themselves manifest in all the three magnetic elements, which became less violent during the early part of the morning of the 29th. At 4 A. M. Aug. 29th, the horizontal intensity was 0·0020 below the mean for the previous ten days, and then increased until $8^h\ 50^m$ A. M. when the disturbances assumed so violent a character that the intensity at times, and the inclination very frequently, could not be registered, the scales being out of the

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field of the telescope. At $8^h\ 57^m$ A. M. the horizontal intensity was 0·0284 below the mean above referred to, showing a decrease of 0·0264 in the space of one hour. The variation of the needle underwent similar changes, decreasing rapidly until $9^h\ 35^m$, when it was 36 minutes below the mean for the ten days mentioned above. After 8 A. M. the magnetic instruments were registered every minute. The following table contains the means for declination and horizontal intensity.

	Declination.	Horizontal intensity.
Between 7^h and 8^h A. M.	8° 24′·20	2·36264
" 8 " 9 "	8 22 ·23	2·33677
" 9 " 10 "	8 8 ·52	2·35072
" 10 " 11 "	8 13 ·00	2·34711
" 11 " 12 "	8 22 ·86	2·34983
" 12 " 1 P. M.	8 34 ·33	2·35160
" 1 " 2 "	8 37 ·54	2·35539
" 2 " 3 "	8 37 ·40	2·35755
" 3 " 4 "	8 38 ·46	2·34353
" 4 " 5 "	8 35 ·83	2·35479
" 5 " 6 "	8 34 ·21	2·35412

The above figures do not give the greatest range; that for declination being 1° 8′·8; and for intensity 0·03197 of the absolute unit.

At $6^h\ 10^m$ P. M. the first traces of an aurora were observed towards S.E. by S. The luminous appearance increased rapidly, spreading towards S.W.

$6^h\ 40^m$ P. M. A rosy color appearing on the clouds in S.E. and S.W. by W.

$6^h\ 50^m$. Splendid aurora. Red streamers very bright, S.E., S.W., and W. by S. visible to an altitude of 50° or 90°. One very bright whitish streamer in S.W. by S. looking as if there were a thin red curtain before a beautiful white luminous curtain. Lower edge about 12° above the horizon. Well defined in S. by W. and S.S.W.; upper portion scarce visible at 45°. The folds of the luminous curtain and the red streamers, if produced, would probably meet one another about 10° S. of the zenith.

$7^h\ 15^m$ P. M. Aurora fading away. Red patch in S.

$7^h\ 20^m$ P. M. Red color disappearing from S. to S.W. giving place to white; at the same time the white in S.S.E. becoming reddish.

$7^h\ 21^m$ P. M. Sky in south becoming very bright and white. Low bank of well defined cumulo-stratus 5° to 6° above the horizon.

$7^h\ 23^m$ P. M. A well defined arch of white light 10° to 12° high above the bank of cloud before mentioned, extending from S.S.E. to W.S.W. being brightest in W.S.W.

$7^h\ 30^m$ P. M. Very faintly red in S.E. Two pink streamers. Two whitish streamers, one in the zodiac, and the other through the cross.

$7^h\ 34^m$ P. M. Faint rosy light in E.S.E. nearly as high as the zenith.

$7^h\ 43^m$ P. M. White streamers in S.W. by W.

$7^h\ 49^m$ P. M. A large patch of very bright light in S.E., white below, reddish above.

$7^h\ 50^m$ P. M. A white luminous cloud appearing in S.W. About 30° high, below the southern cross, a rosy streamer in S.E. by E. very faint.

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7h 55m P. M. The white and red light in S.E. increasing in brightness, yellowish white below, and red above. Top 40° high.

8h 3m P. M. Luminosity in S.E. almost gone, especially the red.

8h 20m P. M. Rosy arc from E.S.E. to W. by N., passing nearly through the zenith.

9h 50m P. M. Three red streamers in S.E. very bright, and several white ones in S.W.

12h 15m A. M. Bright broad streamers S.S.W. to S.W. partly covered with clouds.

12h 40m A. M. Luminosity in S. and S.W. 25° high.

2h 15m A. M. Luminosity from S.S.E. to W., brightest in S.S.W.

The magnetic disturbances continued with more or less intensity until 4 A. M. Aug. 30th.

During the whole of the 29th the instruments of the electric telegraph were disturbed to such a degree as to interfere with the working of the lines extending over New South Wales, Adelaide and Victoria. This effect was similar to that produced by atmospheric electricity.

E. Observations at Ballaarat, lat. 37° 36′ S., long. 143° 51′ E.

Aurora visible Aug. 29th at 6h 45m P. M. It gradually spread to the east and formed a magnificent arch, the colors of which were red, green and violet. The rays of light were distinct and beautiful. The southern portion of the sky was illuminated until 7h 30m sufficiently to cast a shadow.

F. Observations at Longwood, lat. 36° 54′ S., long. 145° 41′ E.

At 6h 10m P. M. Aug. 29th, an aurora appeared from a dusky line in the S.W. part of the horizon, which gradually ascended with a tremulous motion towards the zenith, assuming all shapes and varieties of color, from a pale red or yellow, to a deep vermillion, and extending to the N.E., serving to illuminate the earth, until its disappearance at 7h 15m P. M.

G. Observations at Sandhurst, lat. 36° 48′ S., long. 144° 24′ E.

Aurora very brilliant from 7 P. M., Aug. 29th, until a little after midnight.

H. Observations at Beechworth, lat, 36° 22′ S., long. 146° 52′ E.

Aug. 29th. Aurora visible for nearly an hour and a half, commencing about 5h 45m P. M., gradually increasing in beauty and brilliancy of tint until shortly before 7h, when the rays became gradually indistinct, disappearing at about 7h 15m P. M. During the whole day the telegraph wires were strongly affected.

I. Observations at Sydney Observatory, lat. 33° 52′ S., long. 151° 12′ E., made by W. Scott.

The aurora was first noticed, Aug. 29th, at 7h 20m P. M. and continued visible for about half an hour, when it gradually faded away, and the sky became rapidly covered with clouds. I was in the act of observing a transit of the Pole star, when I was struck with the redness of the southern sky. On looking out I was surprised to find a considerable portion of the southern sky in a glow of red light, similar to that which sometimes precedes the rising of the sun. This red light formed a tolerably regular arch from E.S.E. to W.S.W., extending in depth from the south pole to within a few degrees of the horizon. There was a partial break to the S.S.W., and in some places there were radiating streams of light brighter and of a lighter red than the rest.

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About 10 A. M., Aug. 29th, the wires of the electric telegraph were seized with an unaccountable fit of restiveness. They did not altogether refuse to work, but acted irregularly, the adjustment of the instrument altering so frequently that it was almost impossible to get any continuous message through. This state lasted until the evening, when the wires began to work better.

From the preceding observations, and from those which have been heretofore published in this Journal, it appears that the remarkable auroral display which prevailed throughout a large portion of the northern hemisphere from Aug. 28th to Sept. 4th, 1859, was accompanied by a display about equally remarkable in the southern hemisphere; and the periods of greatest brilliancy were nearly cotemporaneous in both hemispheres. In order to determine whether such a coincidence is a common occurrence, I have sought for some long and continuous record of the aurora in the southern hemisphere. The most complete record of this kind which I have found is that made at the British magnetic observatory at Hobarton, on Van Dieman's Island during the years 1841–48. These observations have been published by the British Government, and the first part of the following table contains all the instances of auroral exhibitions which I have been able to find in these volumes.

The second part of the table contains the corresponding observations made at New Haven by Mr. E. C. Herrick, who kept a careful record (negative as well as positive,) of all auroral phenomena from 1837 to 1853, except from Mch. to Sept. 1851.

The third part of the table contains auroral notices from the State of New York, as published in the annual Regents' Reports; and the fourth part of the table contains auroral notices from the Toronto meteorological observations.

I. *Observations of the Aurora at Hobarton, Van Dieman's Island*, lat. 42° 52′ S.
long. 147 27 E.
Magnetic Dip in 1845 70° 35′·6.

Hobarton mean time, Astronomical reckoning.		Notices of Auroras.
Day.	Hour.	
1841. March 16,	17 h.	Slight appearance of Aurora.
March 22,	15	Faint appearance of Aurora.
May 17,	13	Slight appearance of Aurora.
July 20,	9	Aurora very brilliant in S.E.
Dec. 17,	11	Slight Aurora in south.
1842. Jan. 1,	11	Appearance of Aurora to the south.
Feb. 2,	9	Slight appearance of Aurora in S.W.
Feb. 18,	9	Appearance of Aurora in the south.
April 11,	9	Slight appearance of Aurora in the south.
April 13,	13–15	Aurora in the south.
April 14,	9	Aurora in the south.
April 15,	9	Aurora in the south.
May 16,	9–15	Aurora from S.E. to S.
June 13,	11	Faint Aurora in the south.
July 2,	7–11	Slight Aurora in the south.
Sept. 2,	13	Steady bright light in the S.
Dec. 31,	9	Slight Aurora in the south.

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Table continued.

Hobarton mean time, Astronomical reckoning.		Notices of Auroræ.
Day.	Hour.	
1844. April 16,		Aurora in the evening and night.
April 25,	9	Faint appearance of the Aurora.
1846. Sept. 22,		Aurora very brilliant throughout the night.
1847. April 20,		Aurora very distinct during the night.
April 21,		Aurora visible.
Sept. 24,		Aurora very bright.
Sept. 25,		Aurora visible.
Sept. 26,		Aurora visible.
Oct. 22,		Aurora visible and very brilliant.
Oct. 23,		Aurora visible.
Oct. 24,		Aurora still visible.
Dec. 20,		Aurora visible.
1848. March 24,		Aurora very distinct at night.
April 6,		Aurora very distinct at night.
Oct. 18,		Aurora visible.
Nov. 19,		Aurora visible.
Dec. 21,	10	Slight signs of Aurora to the south.

II. *Observations of the Aurora at New Haven*, lat. 41° 18′ N., long. 72° 55′ W.
Magnetic Dip in 1844 73° 21′.

Date.		Notices.
1841.	March 16,	Snowing.
	March 21,	10·45 P. M., faint Aurora; 22d, cloudy.
	March 23,	10 P. M., Aurora with streamers.
	May 17,	Clear. No Aurora seen up to $10^h\ 15^m$.
	July 19,	10 P. M., Aurora with streamers; 20th, clear. No Aur.—$10^h\ 15^m$.
	July 21,	10 P. M., Aurora.
	Dec. 17,	Overcast.
1842.	Jan. 1,	Clear. No Aurora up to 10^h.
	Feb. 2,	Somewhat hazy. No Aurora up to $10^h\ 30^m$.
	Feb. 18,	Overcast.
	April 11,	Aurora with streamers.
	April 13,	Raining.
	April 14,	10 P. M., Aurora reaching 20° altitude.
	April 15,	3 A. M., Aurora reaching 45° altitude.
	May 16,	Hazy: moonshine; no Aurora up to 10^h.
	June 13,	Raining.
	July 2,	Overcast.
	Sept. 2,	8·30 P. M., Aurora with streamers.
	Dec. 31,	Clear. No Aurora up to 11^h.
1844.	April 16,	Overcast.
	April 25,	Overcast.
1846.	Sept. 21,	Aurora; 22d, 8 P. M., Aurora.
1847.	April 20,	Overcast.
	April 21,	Overcast.
	Sept. 24,	Raining.
	Sept. 25,	Raining.
	Sept. 26,	Raining.
	Oct. 22,	Overcast.
	Oct. 23,	Overcast.
	Oct. 24,	Raining.
	Dec. 20,	5 A. M., grand Auroral display.
1848.	March 24,	8 P. M., Aurora with streamers.
	April 6,	9·30 P. M., Aurora with streamers.
	Oct. 18,	Raining.
	Nov. 19,	8 P. M., Aurora.
	Dec. 21,	Snowing.

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III. *Observations of the Aurora at the Academies in the State of New York.*
Magnetic Dip from 73° to 75°.

	Date.	Notices.
1841.	March 16,	Aurora seen at Fredonia.
	March 22,	Aurora at Newberry, Vt.
	July 20,	Aurora seen at St. Lawrence.
1842.	Feb. 1,	Aurora seen at Cortland.
	April 11,	Aurora at Albany, Rochester, and many other places.
	April 12,	Aurora at Malone.
	April 14,	Aurora at Albany and many other places.
	April 15,	Aurora at Rochester and many other places.
	June 13,	Aurora at Ellisburgh.
	July 2,	10 P. M., Bright Aurora at several places.
	Sept. 2,	Aurora at North Salem.
1844.	April 17,	Aurora at Onondaga.
1846.	Sept. 21,	Aurora at North Salem and several other places.
	Sept. 22,	Aurora at Onondaga.
1847.	Oct. 23,	Aurora at Rochester and Casenovia.
	Oct. 24,	3 A. M., Brilliant Aurora at Rochester.
	Dec. 20,	Aurora at Hamilton and Mexico.
1848.	March 24,	Aurora at New York, Fredonia, and many other places.
	April 6,	Brilliant Aur. at Albany, Rochester, and many other places.
	Nov. 18,	morning. Splendid Aurora at New York.

IV. *Observations of the Aurora at Toronto*, lat. 43° 40′ N., long. 79° 23′ W.
Magnetic Dip in 1845 75° 15′.

	Date.	Notices.
1841.	July 19,	Aurora from 9^h to 13^h.
	Dec. 17, 14^h.	Faint auroral light in north.
1842.	Feb. 13,	Rain and snow.
	April 10, 14^h.	Bright bank of auroral light in N.
	April 14, 14^h.	Brilliant Aurora.
	April 15, 8^h.	Aurora visible from 8^h to 14^h.
	July 3, 14^h.	Brilliant Aurora.
	Sept. 2, 9^h.	Faint auroral light at 9^h and 10^h.
	Dec. 31,	Snow.
1844.	April 16,	Auroral light.
	April 25,	Rain.
1846.	Sept. 21,	From 9^h to 17^h brilliant Aurora.
1847.	April 19,	From 13^h to 16^h Auroral light in N.
	April 21,	Rain.
	Sept. 24,	Rain.
	Sept. 25,	Rain.
	Sept. 26,	Rain.
	Oct. 22, 16_h.	Remarkable appearance of Aurora.
	Dec. 19, 17^h.	Aurora. Great magnetic disturbance.
1848.	March 24,	From 9^h to 12^h Aurora.
	April 5,	From 10^h to 15^h Aurora.
	Oct. 18,	Auroral light through the clouds.
	Nov. 19,	Slight auroral light.
	Dec. 21,	Snow.

Part first of the preceding table contains a list of 34 auroras observed at Hobarton. Part second of the table shows that in 11 of these cases an aurora was seen on the same day at New Haven. These observations were not strictly cotemporaneous, for Hobarton and New Haven being in nearly opposite longitudes, when an aurora was seen at Hobarton it could not be seen at New Haven on account of the presence of the sun. Moreover, the New Haven observations were chiefly made in the early part of the night; but in 11 cases an aurora was seen within about 12 hours of its appearance at Hobarton. In several

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cases when an aurora was seen at Hobarton it was cloudy at New Haven, and there were eight other corresponding cases in which an aurora was seen at some one of the Academies in New York, although not noticed at New Haven. In four additional cases an aurora was seen at Toronto, when none was recorded at New Haven or in the State of New York.

There remain then only 11 cases of auroras at Hobarton for which we do not find corresponding observations from one of these three sources in the northern hemisphere, and in eight of these cases the sky was overcast from New Haven to Toronto. The following are the dates of these auroras, and opposite to the dates I have placed notices of auroral or magnetic phenomena from some station in the northern hemisphere.

Date.	
1841. May 17,	Unusual magnetic disturbance at Greenwich, Eng.
1842. Jan. 1,	Unusual magnetic disturbance at Greenwich.
Feb. 18,	Unusual magnetic disturbance at Greenwich. Aurora at Christiana, Norway.
May 16,	Unusual magnetic disturbance at Toronto and Greenwich.
Dec. 31,	Magnetic disturbance at Greenwich.
1844. April 25,	Unusual magnetic disturbance at Philadelphia and Toronto.
1847. April 21,	Unusual magnetic disturbance at Greenwich.
Sept. 24,	Aurora 9^h to 10^h at Greenwich.
Sept. 25,	Unusual magnetic disturbance at Greenwich.
Sept. 26,	Unusual magnetic disturbance at Greenwich. Aurora at Carlisle, England.
1848. Dec. 21,	Aurora in Newfoundland.

It thus appears that in every instance when an aurora was observed at Hobarton, an aurora was seen on the same day in the northern hemisphere; or there were observed unusual disturbances of the magnetic instruments, indicating the existence of an aurora at no very remote station. So far then as a conclusion is authorized from so small a number of observations, we should infer that whenever an aurora is seen at Hobarton, where the magnetic dip is $-70°$, an aurora occurs at some place in the northern hemisphere as far south as where the magnetic dip does not much exceed 75°; in other words, an unusual auroral display in the southern hemisphere is *always* accompanied by an unusual display in the northern hemisphere. As any cause which affects the intensity of the magnetism at one pole of a magnet, usually affects the other pole, so an exhibition of auroral light about one magnetic pole of the earth, is uniformly attended by a simultaneous exhibition of auroral light about the opposite magnetic pole.

New Haven, May, 1861.

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Art. XIII.—*Rock Oil, its Geological Relations and Distribution;* by Prof. E. B. Andrews, Marietta College, Ohio.

My investigations have been directed chiefly to the oil of the coal rocks, and I propose in this paper to give some of my results.

The surface indications of petroleum are oil and gas springs. These springs are found scattered over a very large area.

It is doubtless well known to scientific men that there are, in the West, two distinct geological formations from which petroleum or rock oil is obtained. These are the bituminous coal measures and the Portage and Chemung groups, (the Waverly sandstone of the Ohio Reports). The Portage and Chemung rocks sweep around in the form of a quadrant from northwestern Pennsylvania into southern Ohio and south into Kentucky. Upon these rocks the famous oil regions of Pennsylvania and northeastern Ohio are located. The oil regions of western Virginia and southern Ohio, including a portion of western Pennsylvania, lie in the coal measures. Marietta, Ohio, may be regarded as near the centre of these extensive oil fields.

It is well known that in the manufacture of coal oil a large amount of vapor or gas remains uncondensed. The town of Newark, Ohio, has been lighted for several years by the surplus gas from the oil works there. While it is believed that the oil cannot be produced in the subterranean distillation without the production of gas, it is also reasonable to suppose that at the very low temperature at which this distillation must take place, the formation of gas necessarily implies the formation of more or less oil. Hence in our bituminous coal measures a gas spring doubtless indicates the existence of oil in the rocks below. The great majority of these gas springs are unknown, since they are seldom discovered, except when they appear in streams; and probably the same may be true of oil springs, since the soil would absorb the oil and in only a few cases would it be detected. I have assumed that the oil is the product of the distillation of bituminous strata, at low temperatures. This theory, which is a modification of the old one of distillation (at high temperatures), has recently been brought forward by Prof. J. S. Newberry and has received the sanction of many of our most eminent chemists. The chief objection to it is the fact that the coal, cannel and bituminous, in our oil regions gives no evidence of having lost any of its full and normal quantity of bitumen or hydrocarbons. For example, at Petroleum, Ritchie Co., Va., where strata have been brought up by an uplift from several hundred feet below, seams of cannel and bituminous coal appear, which, if judged by the standard of Nova Scotia or English coals, have lost none

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of their bituminous properties. The cannel coal although somewhat earthy, yields from forty to sixty gallons of oil to the ton.

The other theory, that the oil was produced at the time of the original bituminization of the vegetable or animal matter, has many difficulties in its way. If the oil were formed with the bitumen of the coal, we should expect that wherever there is bituminous coal there would be corresponding quantities of oil. This is not so in fact, for, as will be seen presently, there is no oil except in fissures in the rocks overlying the bituminous strata, and these fissures can be shown to have been made since the coal strata became bituminized. Again, upon this theory it will be difficult to explain the large quantities of inflammable gas always accompanying the oil. If it is generated exclusively from the oil, then we should expect to find the quantity of oil least where the gas springs have for ages been the most active, but at such places the oil, instead of being wasted, is the most abundant.

That the oil is accumulated in fissures in the rocks and that these fissures are more or less vertical there is abundant proof. The oil in the same neighborhood is found at very different depths. It is very seldom that two adjoining wells strike the oil at the same distance below the surface. The accompanying diagram shows the relative depths of oil wells on Burning Spring Run in Wirt Co., Va. It is evident that in this case the oil is not

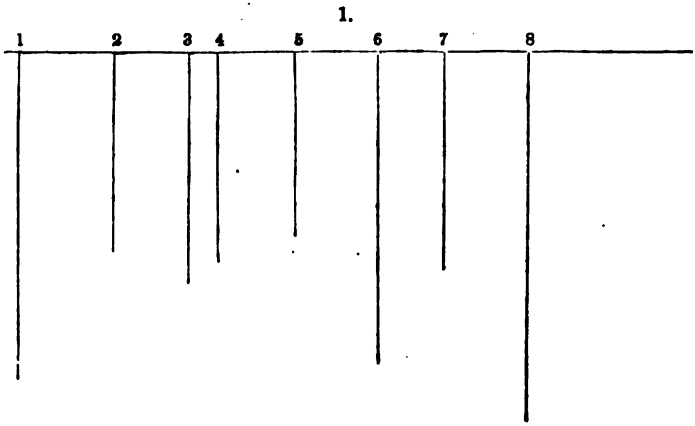


Fig. 1 shows the relative depths of the large wells in Burning Spring Run.

contained in anything like a horizontal reservoir. The famous Lewellyn well marked No. 2, struck an oil fissure at one hundred feet, while the Athens company's well marked 8, struck a large vein at two hundred feet. The oil in the first is said to stand at 41°, (Beaumé,) while that of the latter stands at 33°. On Duck Creek, Washington Co., Ohio, wells very near each other show a difference of ten degrees (Beaumé) in specific gravity.

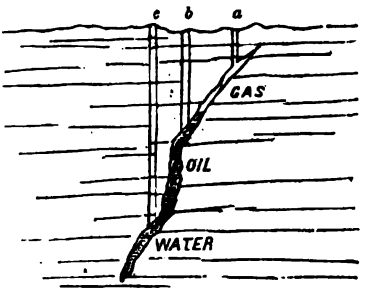
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At Smith's Ferry, in Western Pensylvania, on the Ohio River, much of the oil is of a light straw color, while it is said other wells yield an oil of the more usual dark-greenish color. On the same lease of land and within six or eight rods of the well marked 8 in the previous figure, is a well two hundred and fifty feet deep. The oil from this well is not only different in its specific gravity from that in the other, but the deepest well contains fresh water, while the other contains salt water. From these and similar facts, it is evident that the oil is in distinct and separate fissures and that these are vertical rather than horizontal.

The contents of these fissures are generally water, at the bottom, oil floating upon the water, and gas filling the space above the oil. Where the gas finds an outlet through a crevice in the overlying rocks, there is produced a gas spring. When the water finds an outlet it carries the oil with it and an oil spring is the result. I have found oil springs high up on hill sides.

An oil fissure may be struck at any point. The following figure will illustrate this. The letter *a* (fig. 2) shows the position of a well which strikes near the top of a fissure and in that part which is filled with gas. The gas rushes up but no oil. If again the well is bored at *b*, it will strike oil, and the gas pent up in the upper part of the fissure will force the oil up through the well *b*. There are several oil wells on Little Kanawha in which the gas has forced up very large quantities of oil. The action of the gas however soon becomes fitful and intermittent. If again the well is bored at *c*, it will strike that part of the fissure which contains water. In such case oil can be obtained only by pumping out the water. Doubtless many good oil wells are thought to be worthless, and abandoned because they contain at first only water. If bored at the point *c*, in the water part of the fissure, water alone is to be expected until the pump has been used. There may be floating upon the water, higher up in the fissure, a large quantity of oil.

2.



If the oil is found in fissures in the rocks, it is natural to suppose that in those places where the fissures are the most numerous and largest, the oil would be formed in the largest quantity. This antecedent probability is fully verified by the facts. The rocks of Western Virginia and Southeastern Ohio may be divided into three classes, *those which are almost entirely horizontal, those which have a dip of from fifteen to forty feet in the mile, and*

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those which are broken and dislocated by an uplift. The strata from the Ohio River at Parkersburg up the Little Kanawha to within a few miles of the great oil wells are very nearly horizontal and probably contain few fissures except such as may have been produced by the drying and shrinking of the rocks. There is not to my knowledge a single productive oil well in that region although a large number of wells have been bored. The compact and unbroken clay shales and other strata rest upon the deep bituminous strata and furnish no spaces through which the oil vapor could rise. Probably no such vapor is formed.

On the Great Kanawha River, at Pomeroy and vicinity on the Ohio River, in Athens, Morgan, Noble, Washington and other counties in Ohio, located on the coal measures, the rocks have more or less dip and contain, as a probable result of the uplifting force, many fissures. These counties all furnish oil—Noble and Washington in considerable quantities. The salt wells on Great Kanawha, at Pomeroy on the Ohio, on the Hocking and Muskingum Rivers and on Duck Creek, revealed more or less oil.

But it is in regions where the strata have been the most disturbed and where the fissures are the most numerous, that the most oil is found.

I have recently traced a most interesting line of uplift and dislocation from the eastern part of Washington county, Ohio, to beyond the great oil wells on the Little Kanawha River. The direction of it is nearly north and south. It makes an angle of about 40° with the general course of the Alleghany Mountains. As seen in Ohio it presents a well marked anticlinal axis but with the eastern slope more steep than the western. Near the

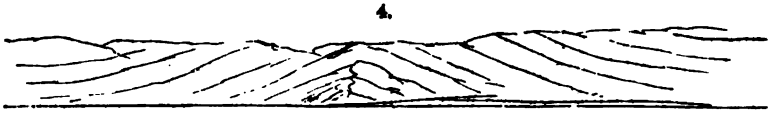
3.



Section on the Ohio in vicinity of Newell's Run.

anticlinal lines at A, fig. 3, are oil and gas springs. A few miles south, on Cow Creek, Va., it is seen as represented by fig 4. At

4.



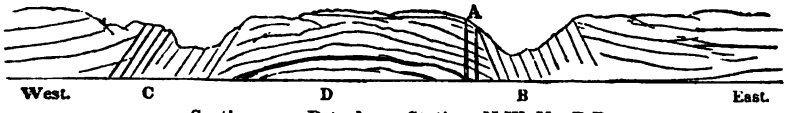
Section on Cow Creek, Va.

the anticlinal line are gas and oil springs. Fifteen or twenty miles farther south, near Petroleum, Ritchie Co., Va., the uplifting force has been greater and the strata have been broken apart

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and now stand on each side at an angle of about 50°. They are represented by the inclined strata B and C in fig. 5. At D, are

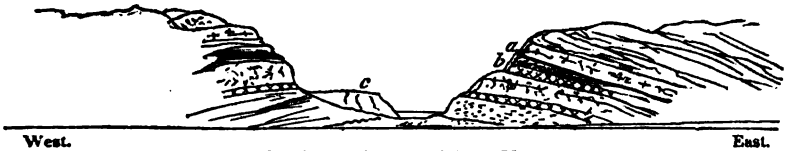
5.



Section near Petroleum Station, N.W. Va. R.R.

seen strata from below, which have been forced up and wedged in between B and C. They have been bent by the great force to which they have been subjected. These strata contain seams of cannel and bituminous coal and are altogether new to me. At A, just within the steep rocks on the east are gas and oil springs and some productive oil wells. At B, is seen the mouth of Oil Run and at C, the mouth of Laurel Fork of Goose Creek, where the rocks of the western dip are finely exposed in a railroad cutting. A few miles further south and on the line of this geological disturbance we find, near where Hughes River crosses the uplift, many new and interesting strata, which have been lifted up from considerable depths. Some of these are shown in fig. 6. At *a* we find a seam of light colored compact flint from

6.



Section on Hughes River, Va.

eight to eleven feet in thickness. At *b* is a seam of shale, brown at the top and blackened with bitumen at the bottom, which is remarkably rich in fossils such as Productus, Chonetes, Bellerophon, &c. The exact equivalent of this deposit of fossils I have nowhere seen in the outcrop of our coal measures.

At *c*, is shown the alluvial bank of Hughes River, out of which large quantities of petroleum have in former years been taken. The oil came up through a fissure in the underlying rock and saturated a stratum of sand and gravel. This stratum was laid bare by removing the superincumbent earth and the oil worked out by hoes from the water and sand. This locality, next to the old Pennsylvania Oil Springs, has probably furnished more oil than any other locality in the country. A few wells have been bored in this region, but with what success I did not learn, nor had I time to investigate the question whether they

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were bored in that part of the geological disturbance, where the largest number of fissures would be found.

Between this point and the Little Kanawha River, the anticlinal line is easily traced, the rocks inclining to the east and to the west at angles varying from 28° to 8°. The rocks are well

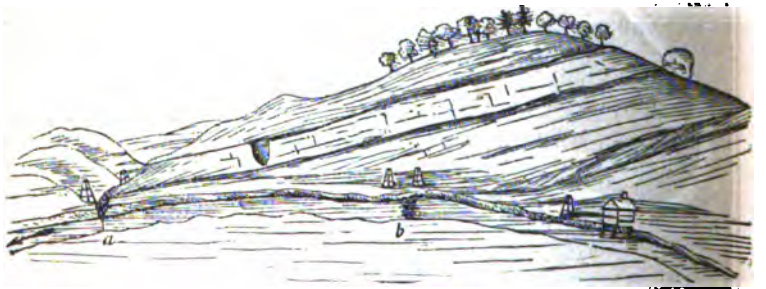
7.



Section on Little Kanawha in vicinity of Burning Spring Run.

exposed on the heads of Standing Stone Creek, and at other points. On the Little Kanawha, a section would be represented

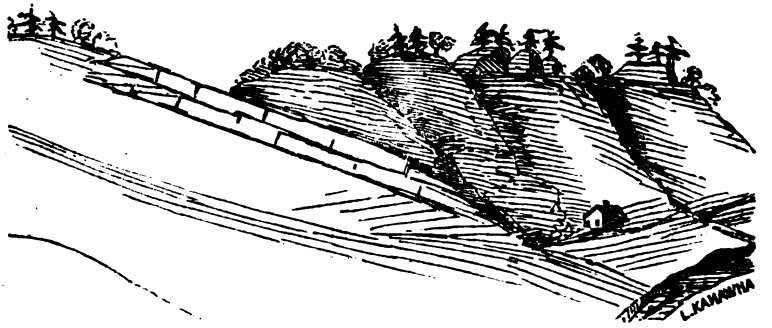
8.



Sec. on Lit. Kanawha R. above the mouth of Nettle Run. Dip West. *a* mouth of Nettle R., *b* ledge of rocks in the bed of river.

by fig. 7. The anticlinal line, or centre of the uplift is seen at A. Near A and extending towards B are the great oil wells.

9.

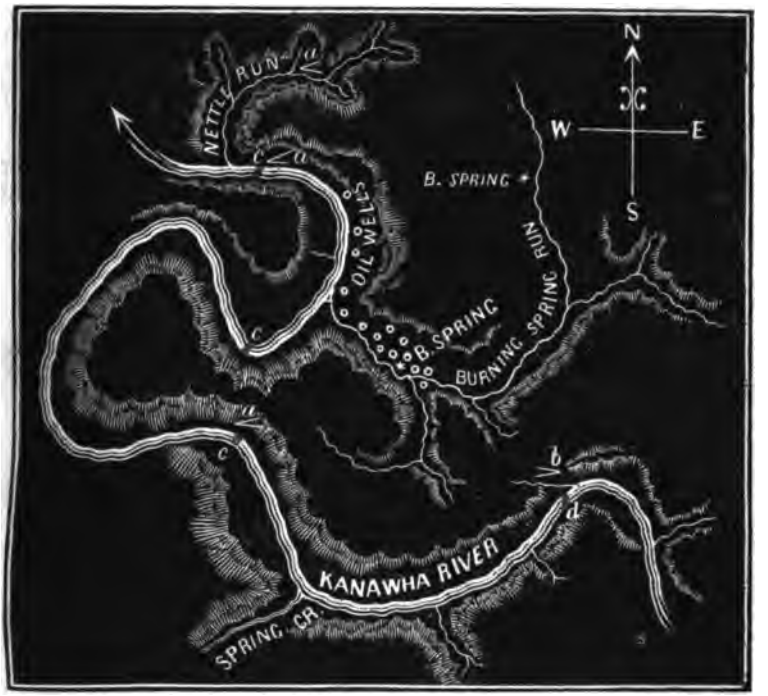


Sec. of Eastern dip ½ mile E. of Burning Spring Run. Dip 11°.

They are exactly where the largest number of fissures would be made by the uplifting force. The accompanying figures 8 and 9

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show the western and eastern slopes of the anticlinal. To the intelligent aid of E. H. Moore, Esq., of Athens, Ohio, I am indebted for the following map of the oil region of Little Kanawha. The directions and courses were taken accurately, the distances only approximately. It is so far as I know the only map of that district. The wells are on the north bank of the river and on a



Map of Little Kanawha Oil Region, Wirt Co., Va.
Scale about 1¼ inch to a mile.

little tributary called Burning Spring Run. The hills in this region are very high. The valleys are all valleys of erosion. The three angles marked *a* indicate the position of the western slope of the rocks. On Nettle Run, the dip is 21°, at the other points, somewhat less. At the points marked *c* are ledges of rock, seen in the bed of the river at low water, produced by the harder of the inclined strata.

At *b* the angle indicates the dip of the strata to the east. The rocks are there inclined at an angle of 11°. At *d* another ledge of rocks is seen in the bed of the river made by hard strata in their eastern dip. The central line or axis, between the two slopes, runs nearly north and south, and along this line the productive wells are found. Thus far, the oil is obtained only

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in a narrow range extending north and south, and little more than one hundred and twenty rods wide. On the west of this range many wells have been bored without success. The exact limit of the oil on the East is not yet known,—but wells, now being bored, will soon determine it. The oil fissures are struck at different depths, as has been already shown, consequently there is no such thing as an "oil rock" as many suppose. The oil is found in any kind of stratum. Each oil fissure doubtless extends vertically or nearly so, through many different strata.

These wells have been unparalleled for the quantity of oil produced. Many of them, when first bored, poured out the oil in torrents, the oil being forced up by the pressure of gas. Hundreds of barrels were obtained from a well in a few hours. The Camden, Lewellyn, Weare and Harper wells and doubtless others, are fine illustrations of this. They yield a marvellous quantity of oil. In many wells the oil is entirely free from water and passes directly from the well into barrels for shipment. The oil varies in specific gravity from 32° to 42° (Beaumé.)

The oil is evidently the accumulation of long ages. The valleys of erosion which cross this line of uplift in almost every direction, and which have been produced by the drainage of the rains falling upon the surface, show that the uplift and consequently the fissures underneath, have existed for a vast period of time. It is therefore probable that during this long period the work of accumulation has been going on. If this is true, it will follow that when a fissure is once exhausted of oil, it may well be abandoned, as it will take a geological period to refill it. The original indications of oil in this region were, as I learn, only the gas springs, of which there were two on Burning Spring Run. Both of them are now destroyed by wells that have taken away the gas. A salt well bored at the mouth of Burning Spring Run, many years ago, yielded a large quantity of oil and it was this salt well which caused attention to be directed to this locality, now so famous.

I have thus shown some of the geological relations of the oil here in the upper part of the coal measures. The *horizontal* strata in Wood and Wirt counties, Va., are, I think, the highest in the series. Containing few fissures, the chances of finding oil in them is necessarily very small.

The *inclined* rocks with a dip of from fifteen to forty feet in a mile, contain more or less fissures and consequently yield more or less oil. It is in these inclined rocks that the productive wells on Duck Creek, O., at McConnelsville, Pomeroy, &c., are obtained.

In the *broken* rocks, as found along the central line of a great uplift, we meet with the largest quantity of oil. It would appear to be a law, that the quantity of oil is in a direct ratio to the

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amount of fissures. By this law, the great wells on Little Kanawha are easily explained. With so much room for expansion, the hydro-carbons of the coal and bituminous strata underneath have risen in the form of vapor and during long geological ages have been filling the fissures with oil.

Since writing the above, I have examined the Report of the Geol. Survey of Kentucky, vol. iii, and find that the oil region which lies in Cumberland county and in several adjoining counties, is probably situated upon a line of peculiar disturbance. Mr. Owen states that "the principal axis of disturbance, already mentioned, which passes in a southwest course through Lincoln, Casey, Russell and Cumberland into Monroe county, probably crosses the Cumberland (river) at the Riffle, near the Turkey River Bend, where a dip of about 4° was observed at the head of the Riffle in a direction of 50° east, while a reversed dip, north 50° west, at about the same angle was noticed near the foot of the Riffle." A careful examination might show that the fissures containing oil in this region are to be found chiefly along the line of this disturbance.

Of a locality in Cumberland county, Mr. Owen thus writes: "On Crocus Creek, the blue limestone dips 2° to the northeast; a short distance up Puncheon Camp, the slate dips at an angle of about 1° in a course south 20° west, while not far off, on the Creek, it dips with about the same angle in a course north 10° to 20° east. Hence it is evident that the dip is very irregular." On Crocus Creek and on other streams in that region large quantities of oil were found many years ago in boring for salt water. From all I can learn, without visiting the region, the oil is found chiefly in the blue limestone and below the black shale. The oil is light in its specific gravity, while oil from similar locations in the geological series, in Ohio, is very thick and tar-like.

The oil from the coal measures varies in specific gravity from perhaps 20° to 52° (B.) Oil from Pomeroy, O., standing at 51° B. burns freely, and with brilliant flame, without distillation.

The heavier oils, such as are not profitable for distillation, afford a very superior lubricating oil. Hence the demand for heavy as well as light oils will doubtless be very great.

Marietta, Ohio, May 20, 1861.

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ART. XIV.—*On the Crystalline Form of the Hydrate of Magnesia from Texas in Pennsylvania;* by GEORGE J. BRUSH.

THE crystalline form of *Brucite* (ṀgḢ) was first studied by Prof. Dana, and shown by him to be rhombohedral,* the specimens examined were minute crystals collected by the writer in the year 1852 at *Low's* Mine in the town of Texas, Pennsylvania. Since then crystallized *Brucite* has been found in great abundance at *Wood's* Mine in Texas; the crystals vary from a microscopic size to sometimes two or three inches in diameter, and crystalline plates with rough prismatic faces of a much larger size are of frequent occurrence. The crystals are generally thin hexagonal plates with rhombohedral planes almost obliterating the prism; occasionally, however, the prism is oblong, the length being two or three times the breadth; they are symmetrically modified hexagonal prisms, and cannot be referred to any but the rhombohedral system.

In a recent article in the *Journal für praktische Chemie*, lxxxii, 368, R. Hermann describes the Texas mineral under the new name *Texalite*, and attempts to show that its form is monoclinic, and that hydrate of magnesia is consequently dimorphous. To establish this important conclusion Hermann gives four crystallographic measurements (approximative, doubtless, as only full degrees are noted), besides an examination of the optical properties of the mineral, and an analysis. The analysis proves, what has been already so well known, that the Texas mineral is hydrate of magnesia free from carbonic acid, and containing a small amount of manganese. The optical examination was made by Dr. Auerbach, and in his communication, quoted by Hermann, he distinctly points out the fact that with polarized light the mineral has the properties belonging to the *rhombohedral* system; the only point upon which the supposed dimorphism rests, then, is the measurement of the angles. Hermann finds that the angle between the basal plane and *four* similar lateral planes is 90°; this is sufficient to prove that the crystal cannot be monoclinic, for this angle corresponds to a right prism, and is an impossibility in the monoclinic system. Besides the basal and the four lateral planes here referred to, the crystal described by Hermann contained two other planes on the acute angles of the four-sided prism, making with the basal planes, the angles, according to his measurements, 115° and 157°. The specimen examined by Hermann was most probably one of those distorted crystals so frequently met with in micaceous minerals. In some hundred or more specimens from this locality which I have examined, the crystals are dis-

* This Journal, [2], xvii, 83.

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tinctly hexagonal, with the rhombohedral planes R and $-\frac{1}{2}R$, in some cases entirely obliterating the prism. The angles measured were as follows: $O:R$ 119°—120°, $O:-\frac{1}{2}R$ 149° 40′, $I:I$ 120°, $O:I$ 90°.

The proof of the rhombohedral character of the mineral is therefore abundantly demonstrated. The fact that Dr. Auerbach's examination of the optical characters of Hermann's mineral referred it to the *rhombohedral* system, would naturally have led one to be cautious in drawing the conclusion that it was dimorphous. This supposed anomaly between the optical characters and the crystalline form is entirely set aside by the facts here presented; we may consequently safely conclude that the assumed dimorphism does not exist, and that the so-called *Texalite* is nothing more than ordinary rhombohedral *Brucite*.

Yale Analytical Laboratory, May 23d, 1861.

ART. XV.—*Correspondence of Jerome Nicklès, dated Nancy, April 13th*, 1861.

Academy of Sciences—Distribution of Prizes.—The session of the 23d of March last commenced by the distribution of prizes, and closed with a eulogy of Legendre the geometrician, pronounced by Elie de Beaumont.

The Astronomical Prize was divided between five observers who have discovered planets in the course of the year 1860.

These astronomers laureate are:

Luther of Bilk, who discovered *Concordia* March 24, 1860; Goldsmith, who discovered *Danaë* at Chatillon near Paris, Sept. 9, 1860; Chacornac, who discovered a planet not yet named, at Paris, Sept. 12; Ferguson, who discovered *Titania* Sept. 14–15 at Washington; Forster and Lesser, who discovered *Erato* Sept. 14–15, at Berlin.

Concordia is the first of the five telescopic planets discovered in 1860. It is remarkable that the other four were all discovered in September, within an interval of five days. Erato was seen by Forster and Lesser while searching for the planet which Chacornac had discovered Sept. 12.

Lescarbault was not included in this number, his *observation of the passage of a planet across the sun's disk*,* March 26, 1859, not having been confirmed by other observations.

The Cuvierian Prize.—This is a triennial prize designed to reward researches in the different branches of Natural Science to which Cuvier was most devoted. It has been awarded three times. The first time to Agassiz for his work on *Fossil Fishes;* the second to Müller of Berlin; the third to Owen. Now this prize has been awarded to Léon Dufour of St. Sever (Department of Landes), for his patient researches in natural history prosecuted for more than half a century. Following in the footsteps of Swammerdam and Réaumur, Léon Dufour has been occupied mostly with the study of the organization and habits of insects.

* See this Journal, [2], xxix, p. 415.

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In a long series of anatomical monographs he has shown the general characteristics of the interior structure of all the principal representatives of this great division of articulate animals. Residing since 1814 in a small village at the foot of the Pyrenees he has devoted to anatomical investigations all the time which his profession of medicine left at his disposal, and even now at the age of more than 80 years, it is in researches of the same kind that he fills up the leisure of a green old age. The love of science has always been his only motive and the numerous services which he has rendered to zoology have brought him neither riches nor honor.

Among the works presented for the Cuvierian prize the Academy has noticed those of the American Zoologist, Girard, upon the *Ichthyologic Fauna of the Western Regions of the New World, and upon the Reptiles collected during the voyage of Capt. Wilkes in the Antarctic Seas.* This work, says the Commission,* is not unworthy to take a place with the beautiful and important works with which Mr. Dana, the principal Naturalist of that Expedition, has enriched science, and the Commission consider this a fitting occasion to testify publicly the satisfaction which they experience in the zoological studies undertaken in America, and that so great an undertaking finds there such powerful encouragement.

Chemical Prize.—The 1st prize of 3500 francs has been awarded to Berthelot "for his researches in Chemistry relating to the production, by synthesis, of certain chemical compounds existing in living bodies." The 2d prize of 2000 francs was awarded to Dessaignes "for the production of succinic, aspartic, hippuric, aconitic, fumaric and racemic acids, by the transformation of gelatine sugar."

The Report adds the following: "In making mention, at the present session, of the remarkable labors of Pasteur, the section of Chemistry wish to reserve the liberty of considering them in their full extent hereafter, both in regard to the past and to the future."

It is here proper to say that Pasteur, who has especially shared the prizes of the Academie des Sciences, will next year have a new prize of 6000 francs for the same class of labors which have been recompensed so frequently and in all forms.† This is a consoling circumstance proving that if, as the Commission of the Cuvierian prize say, there are savans whose labors have conduced neither to riches nor honor, the counterpart is equally true in France.

Prize in Experimental Physiology.—This prize was taken by Stilling (of Cassel) for his great work upon the "Structure of the Spinal Marrow." Honorable mention was accorded to Philipeaux and Vulpian for their experimental Researches, "*Sur la régéneration des nerfs séparés des centres nerveux*:" and to Faivre for his work, "*Sur la modification qu' éprouvent après la mort, les propriétés des nerfs and des muscles chez les grenouilles.*"

Among the *medical prizes* we may mention that given to Devaine for the "*Traité des Entozoaires et des maladies vermineuses de l'homme et des animaux*," a work which compared with what had previously

* Composed of Messrs. Flourens, Elie de Beaumont, Geoffroy St. Hilaire, Serres and Milne Edwards (reporter.)

† See this vol., p. 1, for a notice of Pasteur's recent labors.

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appeared, forms an era in science and in medicine so far as they are concerned with the intestines. A prize was also decreed to Bergeron for his treatise upon *Stomatite ulcereuse des soldats* (soldier's sore mouth). This is a contagious disease which may be reproduced with some modifications by inoculation; this the author proved upon himself. According to documents collected by him it appears to be demonstrated that the appearance of ulcerated mouth was epidemic in the French army near the end of the eighteenth century. It happened that of all the great armies of Europe, those of Portugal and Belgium together with the French army, were the only ones in which this disease was observed in the form of an epidemic. The crowding of soldiers in the camp, in the barracks, and in the body guard, appears to have been the principal cause of the development and propagation of this affection. Bergeron has introduced the chlorate of potassa in the treatment of this malady. This method shortens the period of the disease, and if employed in the commencement it frequently obviates the necessity of sending the soldier to the hospital.

Among the Doctors Laureate of the Section of Medicine are also Doctors Turck, and Czermack, of Vienna, for the perfection which they have given to the *laryngoscope;* and Marey, for an instrument which registers the beats of the pulse. It is known that to observe the pulsation of the artery it is necessary to make considerable pressure upon the vessel. Recently Vierordt made experiments of this sort with his *sphygmograph.* This instrument, which caused serious errors, has been gradually perfected by Marey, who subjects the artery to elastic pressure which can be graduated at will according as the pulse is more or less depressed, that is to say, in proportion to the greater or less tension of the blood in the artery. This elastic instrument receives from the vessels alternate motions of elevation and depression, transmitting them to a lever which magnifies them and expresses faithfully every motion on an enlarged scale.

Subjects proposed for prizes next year.

The following are some of the subjects announced for the grand prizes in physical sciences for next year:

1st. Comparative anatomy of the nervous system of fishes.

2d. The study of vegetable hybrids in reference to their fecundity and the perpetuity or non-perpetuity of their characteristics.

3d. The changes which take place during germination in the constitution of the tissues of the embryo and perisperm and in the substances enclosed in these tissues. Also to attempt by reliable experiments to open a new course of investigation upon the "generations called spontaneous."

Numbers 1 and 2 should be presented before Dec. 31, 1861.

No. 3 should be presented on or before Apr. 1, 1863. Each prize consists of a gold medal of 3000 francs.

Medical prizes.

1st. History of the Pellagra. (*Scorbutus Alpinus* or *Elephantiasis Italica.*)

2d. The application of electricity to therapeutics.

Each prize is one of 5000 francs.

Besides these there will be prizes for discoveries or inventions relating to the healing art; prizes will also be given to those persons who shall find means of rendering an art or a trade less unhealthful.

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Grand Surgical Prize—For the preservation of limbs by the preservation of the periosteum.—This is a prize of 20,000 francs, to be awarded, if there is a suitable occasion, in 1866. The following is an extract from the explanation of the object for which this prize is offered as published by Flourens.

"Numerous facts have proved that the periosteum has the power of producing bone. Recently some remarkable facts in human surgery have shown that very extended portions of bone have been reproduced by the periosteum which remained. The time appears to have arrived to call the attention of surgeons to a great and novel study which is interesting at once to science and to humanity. Those who engage in it will not forget that their labor is at once practical and that they are laboring for man, and that it draws no less upon their respect for humanity than upon their intelligence."

The Academy had decided that the prize should be 10,000 francs. When informed of this decision the Emperor, fully appreciating the benefits to be derived from such progress in surgery, immediately caused a communication to be sent to the Academy that the prize should be doubled.

The prize will therefore be 20,000 francs. The essays, written in French, should be presented to the Secretary of the Institute before the 1st of April, 1866.

Employment of Glycerine in Surgery.—The first application of glycerine in the treatment of disease appears to have been made in England about the year 1846. Having been first employed in certain diseases of the skin, it was applied by Dr. Demarquay in the treatment of wounds, ulcers, and certain affections of the genital organs. It was afterwards successfully applied to the dressing of wounds and even to those which had become painful. In an epidemic of hospital gangrene which occurred at the Hospital St. Louis at Paris after having employed without success lemon juice, nitric acid, and the red oxyd of iron, Demarquay made use of glycerine with a success surpassing his expectations.

Antagonism of the poisoning effects of strychnine and curare.—We have previously noticed* experiments on this point made by Dr. Vella of Turin. The author has shown that the curare destroys the effects of a dose of strychnine which would produce death when taken alone into the stomach or when injected into the veins. For by exhibiting together the curare and the strychnine, either separately or previously mingled, far from increasing the poisonous action of these substances, it is possible to neutralize them and cause their effects to disappear. The two substances do not exercise any chemical action upon each other, from whence it appears that the antagonism of their poisonous effects results from action wholly physiological.

An unpublished memoir by Lavoisier.—The works of Lavoisier are to be published at the expense of the government, and under the auspices of the minister of public instruction. Dumas, who has undertaken to edit them, has found many of his writings hitherto unpublished, one of which has just been published in an extremely interesting volume enti-

* Vol. xxix, 269, March, 1860.

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tled, "*Leçons de Chimie professées en* 1860, *par MM. Pasteur, Cahour, Wurtz, Berthelot, Sainte Claire Deville, Barral et Dumas.*" Each of these savans has prepared a lecture upon a subject of his own selection. We shall notice these subjects further on in the bibliography—we only state here that the lecture by Dumas is designed to make known two unpublished documents which he has discovered, the one written by Lavoisier, the other by Leblanc the inventor of the artificial soda.

The paper of Lavoisier relates to the chemical statics of organized beings and is at least fifty years in advance of the scientific knowledge of his times.

We all remember the sensation occasioned at the appearance in 1840, of a work of Dumas and Boussingault, entitled, "*Leçon sur la statique chimique des êtres organisés,*" and which was so brilliantly expounded by Dumas at a session of the Faculty of Medicine of Paris. But the harmony which was thus announced—the discovery of which was the fruit of twenty years labor—this brilliant discovery Lavoisier had long before foreseen. Dumas says, "Six years before the publication of *La statique chemique des êtres organisés,* I received from the Academie des Sciences at the instance of the Minister of Public Instruction, the appointment to collect the information necessary for giving advice in relation to an edition of the works of Lavoisier. On that occasion Arago made known to us the existence of the records of the laboratory of Lavoisier, then in his possession, and also of writings of this great man remaining in the hands of his family. These papers having been communicated to me I proceeded to a careful and attentive examination of these noble relics."

It was quite recently while examining the administrative papers of Lavoisier, seeking for information in regard to the prize founded by the Academy in reference to the decomposition of sea salt, for the purpose of extracting soda, that Dumas discovered a note, wholly in the handwriting of Lavoisier. This note, probably written as early as 1792, appeared to be the programme of one or more prizes which it was proposed to found in the name of the Academy.

We have space for only a few reflections suggested by the interesting memoir of Dumas. Seventy-five years after the hand of Lavoisier traced those lines, the world gains from them new evidence of the genius of this great investigator. This memoir testifies also the great modesty of Lavoisier. To it he committed in a way calculated to conceal his personality, absorbed as it was by that of the Academy, truths which were revealed only a half century after his death and as the result of studies which employed twenty years of the lives of those who like Liebig and others, thought they had discovered them for the first time.

The following is the note of Lavoisier:—

"Vegetables obtain the materials necessary for their organization from the surrounding air, from water, and in general from the mineral kingdom. Animals feed either upon vegetables or upon other animals, which have been themselves nourished by vegetables, so that the materials of which they are formed are in the last resort drawn from the air or from the mineral kingdom.

"Finally, fermentation, putrefaction and combustion are perpetually

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returning to the atmospheric air and to the mineral kingdom the substances which vegetables and animals have borrowed from it.

"By what processes does nature keep in motion this wonderful circulation between the two kingdoms? How does she form substances combustible, fermentible and putrescible with combinations which did not previously possess these properties? These are impenetrable mysteries. We thus dimly perceive that while combustion and putrefaction are the means which nature employs for returning to the mineral kingdom the materials which she has drawn from it to form vegetables and animals, vegetation and animalization must be operations the reverse of combustion and putrefaction.

"It is therefore to animalization, or the nutrition of animals, that the Academy invites the attention of savans of all nations. The Academy does not conceal the fact, that the problem which it proposes for solution embraces an immense extent, that it supposes an analytical knowledge of those substances which serve as nutriment to animals, the alterations which they undergo successively in the canal which receives them by the mixture, 1st, with the saliva, 2d, by mixture with the gastric juice, 3d, by mixture with the bile, which supposes even to a certain extent the analytical knowledge of these different fluids and humors. It supposes also a knowledge of the gases which are disengaged during the process of digestion, the manner in which digestion furnishes to the blood that which is thrown off from it by respiration. In fine, as animals in a state of health and when they have attained their full growth recover from the losses suffered each day and regain the same weight they had the previous night, consequently the loss and gain are equal, the loss being compensated by the food which the animals consume daily.

"The Academy in thus presenting the whole scope of a great theme does not suppose that any one who undertakes will be able to resolve it completely. But the Academy permits each one to handle the problem in such a manner as he thinks convenient and the prize will be proclaimed in favor of him who shall resolve any portion of the subject. It hopes moreover to be able to recompense by its acknowledgements, those who undertake the investigation but do not obtain the prize.

"The Academy therefore intends to repropose from time to time the different portions of the same subject which have not been previously treated."

Dumas concludes his memoir as follows: "If it is asked what were the ideas and opinions of Lavoisier in regard to questions in organic chemistry, we must reply,

1st. He had discovered the process which serves to make all organic analyses, viz, their combustion by oxygen.

2d. That he had learned also, as his laboratory records show, that instead of burning them in oxygen gas he was able to burn them by means of metallic oxyds, and instead of measuring the resulting carbonic acid gas, he had the means of weighing it after having absorbed it in two successive flasks of liquid potassa.

3d. That he believed the bodies belonging to organic chemistry ought to be considered as the oxyds or acids of compound radicals.

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4th. Lastly, that he understood the principal characteristics which distinguish the life of animals from that of plants; the character which pertains to each of the two organic kingdoms in the equilibrium of the forces of life; the part also which mineral matter serves in organic nature, combustion, and generally all which relates to its reduction."

The second unpublished document in this volume is by Leblanc, the inventor of the process for preparing soda from sea salt. This document relates to the mode of action of nitrogenous substances employed as fertilizers.

The tunnel of Mount Cenis.—We have frequently noticed this gigantic enterprise* the object of which is to pierce the Alps and to unite Italy and France by means of a grand tunnel passing under the *Col de Fréjus* to the southwest of Mount Cenis and where it had a height of 2949 metres (9675 feet.) We have seen that the subterranean passage terminates in Italy near the village of Bardonnèche and commences in Modane a small village in Savoy (in France). It debouches at a hundred metres above the road which leads to Turin across Mount Cenis. The subterranean way is 1338 metres (4390 feet) above the level of the sea. It has above it 1610·73 metres of calcareous rock. By reason of this enormous superincumbent mass, it is not possible to open ventilating shafts. The road will be subterranean through its whole extent and have no communication with the free air except at its two extremities. The length of the tunnel will be 12250 metres (40,191 feet or a little more than 7½ miles).

As yet the work of piercing the tunnel has advanced very slowly: on the side of Bardonnèche it has not advanced beyond 600 metres, and on the side of Modane where the rock is harder it proceeds with a little less rapidity and it has penetrated only 500 metres into the interior of the mountain. The works do not advance very rapidly and will require considerable time for their completion in spite of the labor incessantly put forth to perfect the means of excavation.

A problem more difficult to be resolved arises from the necessity of renewing the air in the interior of the tunnel, on account of the resistance which the compressed air meets with in the ventilating tubes. These tubes are 20 centimetres (about 8 inches) in diameter. The friction which they exert increasing in proportion to the distance passed over will be very great, perhaps not admitting of a solution. The question will be to give motion to machinery in the tunnel by means of air compressed in reservoirs with walls sufficiently strong as was proposed in 1858 in this Journal† as a motor suitable for working in long tunnels.

Obituary.—*Cordier* (Pierre, Louis, Antoine) died the 30 of March last at the age of 84 years. Born at Abbeville March 31st, 1777, in 1793 he entered the school of public works and passed in 1795 into the Corps des Mines. He joined the expedition to Egypt as a member of the Scientific Commission. He there executed many topographical labors, especially excavating the ruins of Sané (the ancient Tanis). On his return to Europe having been shipwrecked upon the coast of Calabria he profited by the misfortune by studying the mineralogy and geology of

* This Journal [2], xxv, p. 96. † Ibid. [2], xxvi, p, 98.

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that province of Italy. Returning to France he resumed in 1808 his position of Engineer. Always at his studies, he continued, with the advice of Haüy, his researches in mineralogy and geology which were commenced under Dolomieu. In 1804 he was at the Canary islands where he studied the action of volcanoes.

Taking for the object of his studies a science which was then in its infancy, Cordier became without much effort one of the founders of the science of geology. His investigations, the friendship of Haüy and the protection of the mineralogist Ramond, secured him admission to the Academie des Sciences where he took the place of Haüy in 1822.

Nominated general inspector of mines in 1831 he thenceforward performed the administrative duties of the office.

He was not without honors and dignity under the dynasty of Louis Philippe, and in the meanwhile he preserved all his independence and was never the courtier of power.

In the midst of his administrative functions Cordier still performed his duties as Professor of geology at the Jardin des Plantes, where he continued to the last a course in which geology was taught as it had been in 1825. Cordier had neglected paleontology; he was the oldest engineer of mines as he was the representive of the old school of geology, and he had little favor for the new theories and doctrines which had transformed science around him.

Acclimation.—Sheep.—The Zoological Society of Acclimation continue their labors with success, and find themselves in correspondence with all parts of the world. At the garden of acclimation which was founded in the Bois de Boulogne the Society has established weekly consultations upon different questions relating to acclimation and domestication; it has founded prizes many of which have been awarded this year to recompense real success. A number of these have been given for the propagation of sheep called *Graux de Mauchamp*, originated but a few years since and now celebrated for its beautiful and silken fleece. This race of sheep was originated about 1850 by a distinguished cultivator M. Graux: a lamb having been born at Mauchamp with a fleece of a remarkable silken quality he undertook to obtain a new race of sheep and by superior intelligence he was successful.

At present the silky wool called Graux de Mauchamp has taken an important place in French industry, and even in 1855 it had become celebrated. These results have been obtained by Davin a woolen manufacturer. Since then this manufacturer has introduced to commerce and industry the fleeces of *lamas*, and *alpacas*, the fine hair of the *camel* and of the Angora goat introduced into France and Algeria by the Society of Acclimation. The flesh of the Angora goat also constitutes an excellent article of food.

Acclimation of the Silkworm.—This question, in which the Society of Acclimation has been engaged since it was founded continues to be studied with great activity. The cold and rainy season of 1860 was not favorable for attempts at propagating in the open air either the silkworm of the Ailanthus glandulosa, or of the Ricinus; the latter of which has been introduced from the Canary isles. The difficulty in our country, is to delay the hatching of the cocoons until the Ricinus puts forth leaves.

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M. Guèrin-Mèneville has been engaged in this enterprise and has already met with some success. This desirable result, of having a crop only in summer, has been realized with the silkworm of the mulberry tree, why has it not been obtained with that of the Ricinus?

Acclimation of the Ostrich.—For a long time the possibility of acclimating the ostrich has been doubted, the giant of birds, it has been said, like the elephant the giant of quadrupeds, refuses to permit its posterity to be enslaved. This is an error. In Algeria in the garden of acclimation the ostrich is fruitful and rears its young as well as at Florence in the zoological garden of Prince Demidoff and also in the royal park of acclimation in Spain. It remains to be known whether individuals born and reared in captivity can continue their species. If the Society of Acclimation undertakes the domestication of the ostrich it is because this bird furnishes a great trade, 1st, in plumes; 2d, in eggs, one of which is worth twenty-one hen's eggs; 3d, the flesh is very excellent. The society seeks to introduce in France and Algeria the *Nandon* (Nontornis) a small species of ostrich which lives in South America (Patagonia), the *Dromie casoar* of New Holland, which like the ostrich is a true bird of prey and the plumage of which is an article of commerce.

Acclimation of the Cotton-Plant.—We have recently mentioned the successful efforts made to popularize the culture of cotton in Algeria. Recently a new impetus has been given to this culture which in 1858 reached 1000 hectares and in 1859, 1,717. Laborers were wanting to give activity to this desideratum of commerce, but they are about to be supplied by the introduction of Chinese coolies. England is making great efforts for the culture of cotton in India, in Egypt, at Port Natal and in China. The interior of Africa where cotton grows spontaneously has recently attracted attention and the 750 bales of very fine Georgia cotton which Algeria furnished in 1858 have now (April 12, 1861) been excelled.

Bibliography.—The following works have been published by HACHETTE, *rue* Pierre-Sarrazin, Paris:

Leçons de Chimie professées en 1860, 1 vol. 8vo.—We have spoken above of this work in connection with the works of Lavoisier.

These lectures are upon subjects in which the several authors have made investigations or discoveries, viz:

Pasteur, upon molecular dissimilarity.

Cahours, on the history of organic radicals.

Wurtz, upon the glycols.

Berthelot, on synthesis in organic chemistry.

H. St. Claire Deville, on numerical laws in chemistry and the variation of their constants.

Barral, on the influence exercised by the atmosphere upon vegetation.

Dumas, historic memoirs concerning Lavoisier and Leblanc.

Payen.—Précis de Chimie industrielle, 4th edition. 3 vols. 8vo. with plates.—This fourth edition comprises a great number of improvements introduced in the chemical arts. The work is divided into two parts, viz. 1st, Chemical arts concerned with mineral substances. 2d, Industrial arts which deal with organic substances. The most important progress noticed in this work is in relation to *sulphur*, *oil*, *caoutchouc*, *glass*,

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preservation of wood, sugar, distillation, gelatine, paper, illuminating gas, heating by gas, the bituminous cements, &c.

Péclet.—Nouveaux documents relatifs au chauffage, 1 vol. 4to. with plates.—This volume which follows the great work of Péclet entitled "*Traite de la Chaleur,*" relates especially to the heating and ventilation of public establishments, as hospitals and prisons. We find here interesting details in regard to the heating of the Hall of Sciences of the Institute and of the celebrated glassworks of Baccarat. There are also the usual formulas in relation to cooling and the transmission of heat through different bodies.

Payen.—Des Substances Alimentaires.—A small 12mo. treating of the methods of improving alimentary substances, of preserving them, and also of detecting their adulteration. This is a synopsis of the course of public lectures by Payen at the Conservatoire des Arts et Métiers, delivered by request of the government.

Heuzé.—Les Plantes Industrielles. 2 vols. 8vo.—This work follows a treatise on fertilizers by the same author, which we have already mentioned. The new work treats of the culture of plants which furnish the food of commerce and such as are used in the arts. Tome I treats of *oleaginous* plants, *tinctorial* plants, *saliferous* plants, and those used as *condiments,* &c. Tome II is devoted to *textile, narcotic, aromatic* and *medicinal* plants: and plants which produce sugar and alcohol.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.

(1.) *On the propagation of heat in gases.*—MAGNUS has communicated to the Royal Academy at Berlin, a memoir on the propagation of heat in gaseous media, the principal results of which are as follows:

1. The temperature which a thermometer finally assumes in a space which is warmed from above is different when this space is filled with different gases.

2. This temperature is higher in hydrogen than in any other gas.

3. The temperature is also higher in this gas than in vacuo, and the greater the density of the gas, the higher is the temperature.

4. Hydrogen therefore conducts heat like the metals.

5. In all other gases, the temperature which the thermometer finally assumes, is lower than in vacuo, and the more dense the gas employed, the lower is the temperature.

6. We must not however conclude from this that gases do not conduct heat, but only that they do this to so small an extent that the action of the conduction is counteracted by the resistance which they oppose to the passage of heat.

7. The remarkable conducting power of hydrogen is shown not only when this is freely moveable but also when it is contained between pieces of eiderdown or any other substance of a loose texture which prevents its motion.

8. All gases, hydrogen included, offer resistance to the passage of rays of heat, and the more extended they are, the greater is this resistance.

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9. Of all gases, atmospheric air or its constituents conduct heat most perfectly.

10. The passage of heat is different according to the source from which it comes. The rays emitted by boiling water exhibit the greatest differences in their passage through different gases.

11. Of all colorless gases, ammonia transmits the least heat; after this olefiant gas.

12. By the application of a tube, the action of the rays of heat can be increased like that of rays of light.

13. The character of the walls of the containing vessel changes the proportion in which rays of heat pass through the gases contained in the tube.

14. The character of the walls also changes the proportion in which the rays pass through different gases.

15. From this, it follows, that rays reflected from different surfaces are transmitted by gases, with different degrees of facility.

16. Hydrogen always transmits rays from different sources of heat, less easily than atmospheric air.

17. The marked increase in temperature which a thermometer placed in hydrogen undergoes when the gas is heated from above, does not therefore depend upon a greater capacity of transmission but only on a greater conducting power.

18. The greater conducting power of hydrogen for heat presents a new argument in favor of the analogy of this substance to the metals.

19. Hydrogen also conducts electricity better than the other gases.—*Pogg. Ann.*, cxii, 351. W. G.

2. *On a new Unit of Electrical Resistance.*—Mattiessen proposes to employ as a unit of resistance in electrical measurements, the resistance of a wire composed of two parts by weight of gold and one part of silver, having a length of one meter and a thickness of one millimeter. The author shows that this alloy conducts electricity with almost equal facility at different temperatures between 0° and 100°, that small quantities of impurities do not sensibly affect its conducting power, and that the annealing of the metal is also without sensible influence. The memoir contains empirical formulas by which the small differences in conducting power occasioned by variations in temperature may be taken into account. The standard wire should be varnished to protect it from the action of mercury.—*Pogg. Ann.*, cxii, 353. W. G.

Note.—It remains to be seen if the proposed alloy retains its specific conducting power after it has been frequently used. It is well known that wires of copper undergo great changes in this respect. W. G.

3. *On Spectral Observations.*—Mousson has described a simple arrangement of a prism for exhibiting the fixed lines in spectra from different sources; the author terms this apparatus a spectroscope. A description of the apparatus is prefaced by a mathematical investigation of the conditions which are necessary for the production of a perfectly distinct spectrum, for which however we must refer to the original paper. The apparatus itself consists essentially of a tube blackened internally, and having at one extremity a plate of metal, with an adjustable slit for the admission of light. The prism is placed at the other extremity of the

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tube, so that the eye of the observer may be brought close to its second refracting surface. The tube is attached to an appropriate stand, so that it may be conveniently directed to the light to be examined, and the eye of the observer is protected from extraneous light by a small screen of metal attached to the tube. The edges of the slit must be ground perfectly true.

This apparatus does not require a darkened chamber or delicate and difficult adjustments. It answers equally well for observations on the solar spectrum, on the absorption lines of liquids and gases, on the electric spectra of Masson and Plücker, and on the chemical lines of Kirchhoff and Bunsen.—*Pogg. Ann.*, cxii, 428. W. G.

Note.—This apparatus is constructed in New York by Mr. Charles Sacher, under my direction, the prism being supplied by Mr. Henry Fitz, the well-known optician. The price of the instrument complete with an equilateral flint glass prism, is $25. W. G.

4. *On the Absorption and Radiation of Heat by Gases and Vapors, and on the Physical connection of Radiation, Absorption and Conduction.*—Tyndall has communicated an important and interesting paper on the absorption and radiation of gases which is in some respects complementary to that of Magnus noticed above. The apparatus employed consisted of 1. a copper cube with one of its faces covered with lampblack and filled with water kept boiling. This forms the source of radiant heat; 2. of a brass tube 2·4 inches in diameter and divided into two compartments, *a* and *b*. The portion *a* is destined to receive the gases and vapors; it is closed at its two extremities by two transparent plates of rock salt and communicates with a good air pump: its length is four feet; B is the chamber between the tube *a* and the cube C. A vacuum is kept in this tube, so that the radiant heat traverses the vacuum, before entering the tube *a*. To prevent the transmission of heat by metallic conduction from the cube C, to the tube *a*, the chamber *b* is partly surrounded with an annular space in which cold water circulates. 3. Of a thermo-electric pile furnished with two conical reflectors, and connected with a galvanometer; one face of the pile receives the rays which have traversed the tube *a*. 4. Of a second cube C′ also filled with boiling water and the rays from which fall upon the second face of the pile. Between the cube C′ and the adjacent surface of the pile, a screen is placed, which may be moved backward and forward, so as to make the two sources of heat exactly neutralize each other. A vacuum is then made in the tube *a*, and the chamber *b*, and the needle of the galvanometer is brought exactly to 0 by means of the screen. The gas or vapor to be experimented upon is then introduced into the tube *a*; if it possess a sensible power of absorption, it will destroy the equilibrium previously existing. The deviation of the galvanometer properly reduced gives the measure of the absorption.

In this manner the author experimented with eight gases and 13 vapors, and also with atmospheric air. Oxygen, nitrogen, hydrogen and atmospheric air absorb respectively about 0·3 per cent of the rays of heat; this was the feeblest action observed. The strongest action is that of olefiant gas, which under a tension of one atmosphere absorbs 81 per cent of the calorific rays. Between these two extremes must be placed oxyd of carbon, carbonic acid, protoxyd of nitrogen, and sulphydric acid.

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Below a certain tension which varies with different gasses, the quantity of heat absorbed is exactly proportioned to the density of the gas. Above this tension, the rays on which the principal power of absorption is exerted, are gradually extinguished so that each increase of density produces a less effect. In the case of olefiant gas for instance, by taking a volume of $\frac{1}{10}$ of a cubic inch as unity in a series of fifteen of these volumes, an absorption was obtained exactly proportioned to the quantity of gas; then the relations of the successive absorptions gradually approach an equality.

In the case of vapors, the most energetic action is that of sulphuric ether; the least energetic is that of bi-sulphid of carbon. By comparing small volumes and equal tensions, the absorption of the vapor of sulphuric ether is ten times greater than that of olefiant gas, and 10,000 times greater than that of hydrogen, oxygen, etc. In a fine day in November, the aqueous vapor in the atmosphere produced 15 times the absorption of the air itself. This great absorbing power is exerted upon rays coming from a source of low temperature, whence we must conclude that the aqueous vapor in the atmosphere must powerfully intercept the rays which tend to pass from the earth into the planetary spaces. Variations in the quantity of vapor in the atmosphere would therefore necessarily produce corresponding variations in climate. Oxygen obtained by the electrolysis of water has a power of absorption four times greater than the same substance which has been passed through iodid of potassium. This increase is due to the presence of ozone.

The author studied the radiation of gases by making them pass over a sphere of heated metal from which they rose in a column in front of the thermo-electric pile. In this manner it was found that the order of radiation is exactly the same as that of absorption.

This reciprocity of absorption and radiation appears to the author a simple mechanical consequence of the theory of an ether; but why has one molecule so great and another so feeble a power of producing or arresting calorific rays? The author suggests that the explanation is to be found in the fact that the gaseous elements examined all exhibit radiations and absorptions which are excessively feeble when compared with those of compound gases. In the first case, the action is produced by oscillating simple atoms—in the second place, by oscillating systems of atoms. Thus oxygen and hydrogen, which taken separately or mechanically united produce an effect which is scarcely sensible, when they are chemically united to form oscillating systems of aqueous vapor, are able to produce a great effect.

In like manner, nitrogen and hydrogen which produce little effect when they are separated, exert an enormous action when they are combined to form ammonia. The same relation exists between the absorbing and radiating powers of other simple gases and their compounds.—*Comptes Rendus*, T. lii, p. 364. W. G.

5. *A Note on the power of Polarization of American Oil of Turpentine;* by Dr. F. Mahla. (In a letter to the Editor.)—It has been already mentioned by Guibourt and Bouchardat, that the American oil of turpentine possesses a power of rotation of 18°·6 to the right.

Numerous experiments with commercial spirits of turpentine enable me to state, that its power of rotation is far from being constant. I have ex-

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amined specimens, which had a power of rotation of 14° (28° in my instrument with a tube of 200 millimetres) while others turned it 20° to the right. Most of the specimens possessed a power of rotation of 19°·5.

Oil of turpentine of 19°·5 subjected to distillation together with water, yielded two oils of different rotating power. The first distillate rotated 22°·5,—the last portion 16°·38.

The rotating power of neither of these two portions was changed by redistillation.

The boiling point of the first portion was a few degrees lower than that of the second portion. It commenced boiling at 295° F., while the thermometer was constantly rising, until it reached 312°. The second portion did not boil before the thermometer had reached 309° F. The final boiling point of the latter did not exceed 315° F.

These data seem to indicate that the American oil of turpentine consists of two or more different hydro-carbons, which are probably polymeric to each other.

Chicago, Jan. 12, 1861.

CHEMISTRY.—

6. *On Salts of Chlorine and other Electro-negative Elements.*—SCHÜTZENBERGER has succeeded—according to his own statement—in preparing acetates of chlorine, iodine and other electro-negative radicals. When acetate of soda is mixed with chlorid of iodine the ensuing reaction is represented by the equation

$$C_4H_3NaO_4 + ClI = C_4H_3O_4I + NaCl.$$

The new substance $C_4H_3O_4I$ is solid, white, and crystalline; it is isomeric with iodacetic acid $C_2(H_2I)O_4H$ but differs from it entirely in properties. Anhydrous acetic and hypochlorous acids unite at a low temperature and form acetate of chlorine,

$$C_4H_3O_3 + ClO = C_4H_3O_4Cl.$$

This compound is a colorless liquid: it is decomposed by water into acetic and hypochlorous acids; it explodes violently near 100° giving chlorine, oxygen and anhydrous acetic acid. Even at ordinary temperatures it is gradually decomposed. An acetate of cyanogen appears to be formed by heating a mixture of equal equivalents of acetate of silver and iodid of cyanogen. Anhydrous sulphuric acid absorbs anhydrous hypochlorous acid, giving a very stable dark red liquid which the author believes to be a sulphate of chlorine SO_4Cl or $S_2O_8Cl_2$. These results require confirmation but if reliable are of great interest and importance. —*Comptes Rendus*, lii, 135. W. G.

7. *On Polyglyceric Alcohols and Anhydrids.*—LOURENÇO has found that glycerine like glycol is capable of forming polyatomic molecules by what may be regarded as successive condensations. Thus ordinary glycerine being represented by the formula

$$\left.\begin{matrix} C_6H_5 \\ H_3 \end{matrix}\right\} O_6 \text{ or } \left.\begin{matrix} C_3H_5 \\ H_3 \end{matrix}\right\} O_3,$$

diglycerine alcohol has the formula

$$2\left.\begin{matrix} (C_3H_5) \\ H_4 \end{matrix}\right\} O_5.$$

It is a colorless thick liquid boiling at 220°–230° in vacuo. The author

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compares this body to pyrophosphoric, phosphoglyceric, and citroglyceric acids, the formulas being

$$\left.\begin{matrix}C_2H_5\\C_3H_5\\H_4\end{matrix}\right\}O_5,\quad \left.\begin{matrix}PO\\PO\\H_4\end{matrix}\right\}O_5,\quad \left.\begin{matrix}PO\\C_3H_5\\H_4\end{matrix}\right\}O_5,\quad \left.\begin{matrix}C_3H_5\\C_6H_5O_4\\H_4\end{matrix}\right\}O_5.$$

A second compound boils at 275° to 285° under a pressure of 10^{mm} and is still more viscid.

Its formula is $\left.\begin{matrix}C_3H_5\\C_3H_5\\C_3H_5\\H_5\end{matrix}\right\}O_7$: it appears to lose water by repeated distillations and to give its first anhydrid $\left.\begin{matrix}3(C_3H_5)\\H_3\end{matrix}\right\}O_6$.

The author also obtained a colorless oily liquid having the formula

$$C_6H_{12}O_4=\left.\begin{matrix}C_3H_5\\C_3H_5\\H_2\end{matrix}\right\}O_4.$$

This compound is formed from pyroglycerine by the elimination of two equivalents of water. The author terms it meta-glycerine or pyroglycide and compares it with Maddrell's insoluble metaphosphate $\left.\begin{matrix}PO\\PO\\Na_2\end{matrix}\right\}O_4$.

Glycide (not yet obtained) would correspond to Graham's metaphosphate

$$\left.\begin{matrix}C_3H_5\\H\end{matrix}\right\}O_2 \text{ to } \left.\begin{matrix}PO\\Na\end{matrix}\right\}O_2,$$

while one of Fleitmann's and Henneberg's metaphosphates would correspond to a triglycerine anhydrid

$$\left.\begin{matrix}3PO\\Na\end{matrix}\right\}O_6 \text{ to } 3\left.\begin{matrix}C_3H_5\\H_3\end{matrix}\right\}O_6.$$

These parallels are very interesting and suggestive.—*Comptes Rendus*, lii, 359. W. G.

8. *On Ozone, Nitrous Acid and Nitrogen;* by T. Sterry Hunt, F.R.S. (Extract of a letter to one of the Editors, Jan. 29, 1860).—The formation of a nitrite when moist air is ozonized by means of the electric spark (the old experiment of Cavendish,) or by phosphorus was shown by Rivier and de Fellenberg, who concluded that the reactions ascribed by Schönbein to ozone were due to traces of nitrous acid. The subsequent experiments of Marignac and Andrews have however established that ozone is really a modification of oxygen, which Houzeau has shown to be identical with the so-called nascent oxygen, which is evolved, together with ordinary oxygen, when peroxyd of barium is decomposed by sulphuric acid at ordinary temperatures. The spontaneous decomposition of a solution of permanganic acid also evolves a similar product having the characters of ozone.

Believing that the nitrous acid in the above experiments is not an accidental product of electric or catalytic action, but dependent upon the formation of active or nascent oxygen, I caused a current of air to pass through a solution of permanganate of potash mixed with sulphuric

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acid. The air, which had thus acquired the odor and other reactions of ozone was then passed through a solution of potash; by which process it lost its peculiar properties while the potash solution was found to contain a salt having the reactions of a nitrite.

As I suggested in this Journal in 1848, I conceive gaseous nitrogen to be the anhydrid amid or nitryl of nitrous acid; which in contact with water might under certain circumstances generate nitrous acid and ammonia. From the instability of the compound of these two bodies, however, it becomes necessary to decompose one at the instant of its formation in order to isolate the other. Certain reducing agents which convert nitrous acid into ammonia may thus transform nitrogen (NN) into $2NH_3$. In this way I explain the action of nascent hydrogen in forming ammonia with atmospheric nitrogen in presence of oxydizing metals and alkalies. (Zinc in presence of a heated solution of potash readily reduces nitrates and nitrites with the evolution of ammonia.)

Now an agent which instead of attacking the nitrous acid would destroy the newly formed ammonia would permit us to isolate the nitrous acid. Houzeau has shown that nascent oxygen is such an agent, at once oxydizing ammonia with formation of nitrate (nitrite?) of ammonia, and thus when ozone (nascent oxygen) is brought in contact with moist air both of the atoms of nitrogen in the nitryl (NN) appear in the oxydized state.

From this view it follows that the odor and most of the reactions ascribed to ozone are due to nitrous acid which is liberated by the decomposition of atmospheric nitrogen in presence of water and nascent oxygen. We have thus a key to a new theory of nitrification and an explanation of the experiments of Cloez on the slow formation of nitrite by the action of air exempt from ammonia upon porous bodies moistened with alkaline solutions. I hope soon to send you the results of my farther inquiries in this matter.

NEW BOOKS.

9. *Die Lehre vom Galvanismus und Electro-magnetismus, von* GUSTAV WIEDEMANN. Braunschweig, 1861. 8°.—The first volume of an elaborate treatise on galvanism and the kindred subjects has just appeared under the above title. The work is in all respects admirably executed and is most complete and thorough. The text is copiously illustrated by excellent wood engravings, each special subject being treated from a mathematical as well as from an experimental point of view. A serious defect is the want of a complete and detailed table of contents or index, which would render the work much more convenient for the purposes of reference. The work is much too elaborate and extensive for a text book, but it presents so complete a view of the present state of the science that it will prove most valuable to the advanced student. It is to be hoped that the second volume will speedily appear. W. G.

10. *Der Electro-magnetismus von* JULIUS DUB. Berlin, 1861. 8°.—This treatise is devoted almost exclusively to the subject of the development of magnetism in soft iron; though the first sections give the theory of the galvanometer in its different forms. The subject of electro-dynamics is not included. Though the author restricts himself to a comparatively narrow field, the work is extensive and thorough, and forms a most valuable contribution to our scientific literature. Prof. Riess' admirable

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treatise on Statical Electricity with the works of Wiedemann, DuBois—Raymond and Dub form an almost complete library of reference for the subject of electricity. A complete general treatise on magnetism is still wanting. W. G.

11. *Les Electro-Aimants et L'Adherence Magnetique par* M. J. NICKLÈS, Paris, 1860. 8vo.—This book is devoted chiefly to a recital of the Author's experiments on various forms of Electro-magnets made during an investigation to test the adaptation of magnetic adhesion for arresting the motion of railway trains. Most of the experimental data have already appeared in this Journal and the Author's proposed nomenclature was given in vol. xxx, p. 413. S.

12. *Die Fluorescens des Lichtes-umgetragen von* J. PISKO. Wien, 1861. 8°.—This pamphlet is a rather popular compilation from the different memoirs which have appeared upon the interesting subject of which it treats. It will prove convenient for reference, especially for the purposes of the lecture room. W. G.

13. *Einleitung in das Studium der Organischen Chemie, von* J. SCHIEL. Erlangen, 1860. 8°.—This excellent treatise followed close upon the author's work on Organic Analysis,* and will be well received as a clear and careful exposition of the views of the new school in chemistry. We are especially pleased with the attention which the author pays to the *physical* portion of the subject. The work includes sections upon crystallography, expansion, fusing and boiling points, tension of vapors, latent and specific heats, densities, specific volumes, evolution of heat in combustion, optical constants, and laws of absorption and cohesion. The chapter on the classification of organic bodies by series is especially original and valuable and the work well deserves translation. W. G.

14. *Allgemeine Encyclopädie der Physik.—Herausgegeben von* GUSTAV KARSTEN. Leipsig. 8°.—The eighth Lieferung of this work has reached us and contains the last part of Schmid's elaborate treatise on Meteorology together with a continuation of Helmholtz's admirable paper on Physiological Optics. The treatise on Meteorology forms the 21st and last vol. of the entire work, the publishers wisely issuing the several treatises as fast as they are prepared without reference to the order of the volumes. The list of contributors embraces many of the first scientists of Germany and the work promises to be a worthy successor to the Physikalisches Wörterbuch of Gehler, now far behind the present state of science, though indispensable as a work of reference. The new Encyclopedia forms properly a collection of separate treatises, each complete and available in itself. The programme embraces 1. Introduction to physics. 2. Crystallography. 3. General theory of forces. 4. Attractions. 5. Applied mechanics. 6. Theory of waves and acoustics. 7 and 8. Pure optics. 9. Physiological optics. 10. Chemical action of light. 11. Applied optics. 12. Action of heat. 13. Theory of Heat. 14. Applied Thermics. 15. Magnetism. 16. Magnetism of the Earth. 17. Frictional Electricity. 18. Galvanism. 19. Electro-magnetism. 20. Applied Electricity. 21. Meteorology. We trust that the work will be pushed forward with an energy commensurate with the magnitude of the undertaking. W. G.

* See notice in this Journal, xxx, 155.

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15. CHEMICAL GEOLOGY:—*Experiments on the deportment of Carbonate of Lime at a high temperature, both with fluxes and alone;* by G. ROSE. —In a recent paper on the heteromorphous states of carbonate of lime, presented to the Berlin Academy of Sciences, Rose gives the following experimental results: I. On heating a mixture in atomic proportions of the carbonates of soda and potash in a platinum crucible until in perfect fusion, then adding small quantities of chlorid of calcium, the latter will be completely dissolved without effervescence. If the fused mass is allowed to cool and a portion of this is placed in water at the ordinary temperature, it will gradually pass into solution leaving a pulverulent residue of carbonate of lime. An examination of this residue shows it to consist of an aggregate of very small globules; after 24 hours—sometimes in less time—these increase in size and are converted either into beautifully crystallized single rhombohedrons, or rhombohedral groups of *calcite.*

II. If another portion of the mass is thrown into boiling water, boiled for some time, and the residue examined under the microscope, it will be found to consist of small prisms of *aragonite*, with occasional rhombohedral crystals of calcite, but none of the above mentioned globules; if the residue be allowed to remain under water, the prisms after a time are converted into minute rhombohedrons of calcite. These phenomena are then identical with those obtained when a mixture of the solutions of carbonate of soda and chlorid of calcium is made, as long since described by the author in his first article on this subject, see *Pogg. Ann.*, (1837), xlii, 354.

III. Instead of adding chlorid of calcium to the fused carbonates, powdered calcite, or rhombohedral fragments of calcite, chalk or aragonite may be substituted; these dissolve completely, without effervescence in the flux and give the same results as above mentioned when the fused mass is treated with hot or cold water.

IV. Oxalate of lime at a low red heat after losing the water it contains is converted into carbonate of lime with evolution of carbonic oxyd; under the microscope the product appears to consist of minute amorphous globules* similar to those obtained above, and these remain unchanged when placed in water, even when boiled the globules still retain their amorphous form—they are not converted into calcite.

From the experiments thus far described it will be seen that rhombohedral carbonate of lime is never a direct product. But according to the well known experiments of Sir James Hall made in 1804, this has been directly produced when chalk and compact limestone were exposed to a high temperature under great pressure. The author assisted by Mr. Warren Siemens, has repeated Hall's experiment. A gun barrel was charged with dry elutriated chalk, this last was rammed into a compact mass, and then the gun-barrel was hermetrically sealed at both ends, and exposed to the heat of one of Mr. Siemens' gas furnaces. During the experiment the barrel sprung, and in the crack there appeared a faint blue flame, evidently of carbonic oxyd, the gun-barrel was then removed from the

* Oxalate of lime is amorphous, and when converted by heat into carbonate, this character still remains.

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furnace. Upon opening the barrel, the chalk was found converted into a compact, light bluish-white coherent mass, slightly lustrous on the fracture, and with cracks running through the whole. The surface was covered with a snow-white, earthy, well defined crust and the cracks were lined with white earthy particles, these, as well as the crust, were composed of caustic lime. The compact mass, however, on examination proved to be unchanged in chemical properties, and its physical properties, though seemingly changed, when examined under the microscope showed the same small globules, and identically the same properties as the unignited amorphous chalk. Although somewhat more coherent the chalk was not materially altered and in no wise converted into crystalline calcite.

The experiment repeated with fragments of rhombohedral calc-spar was also interrupted by the rupture of the gun-barrel. The smaller fragments were converted into caustic lime without change of form, the larger pieces were only superficially altered, notwithstanding the great heat, the inner mass was unchanged and the lime of the surface-crust sharply defined. The same result was obtained by the author under different conditions: Mitscherlich presented him with a mass of limestone from Rüdersdorf which, on account of its size had passed through the lime-kiln without being completely burned. It contained a kernel of unburned lime and, notwithstanding the great heat through which this had passed it proved on examination to have the same characters as the compact limestone which had not been exposed to the heat of the kiln.

It appears therefore, from these experiments, that chalk or compact limestone cannot be converted into crystalline limestone (or calc-spar) by exposure to a high temperature in closed vessels, and as a general fact that rhombohedral carbonate of lime is not formed in the dry way. The author further observes, that on comparing accurately the description of Hall's* experiments and those afterwards made by Bucholz†, that probably they obtained results similar to those just described, and that the slightly coherent but otherwise unaltered mass, was erroneously considered to be crystalline marble.

Notwithstanding the frequency with which this experiment of Hall's has been quoted, and the use that has been made of it not only in explaining geological phenomena, but in serving as the foundation of whole theories, it was never repeated‡ or confirmed and the experiments of the author show how hasty the conclusion was. It is not to be disputed that at the junction with granite and basalt, compact limestone and chalk are often converted into marble, as in Paradiesbacken near Drammen in Norway, and near Belfast, in Ireland, but these changes cannot be considered as due to heat alone, they were manifestly assisted by other agencies, a conclusion also arrived at by Bischof, although in a different manner.—*Pogg. Ann.*, cxi, 156. G. J. B.

* *Gehlen: Neues allgem. Journ. d. Chem.*, v. 287.

† *Gehlen: Journ. f. Chem. u. Phys.*, i, 271.

‡ Bucholz made his observations incidentally in the production of caustic lime from chalk, which in the experiment had not been entirely burned.

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TECHNICAL CHEMISTRY.

16. *On the occurrence of soluble compounds of Copper, Lead and Tin in newly-distilled Alcoholic Spirits.*—In an article discussing the question of the existence of poisonous bodies, especially strychnine, in the spirits produced from grain, which has been so frequently agitated by the public journals during the past few years, Dr. A. A. HAYES expresses his conviction that no good reason can be found for the statements affirming the existence of such substances, which have been made by the newspapers; and remarks that his opinion is founded not only upon an extensive series of analytical observations but is supported by the testimony of the parties most likely to know of such adulteration if it were really made, none of whom had ever met with a case at the places of manufacture which would lead even to an inference that any deleterious body had been purposely added to the distilled spirits.

But while dismissing this bugbear, Dr. Hayes calls attention to another source of danger which may be of importance. "Newly distilled spirits, of the most common kind, often contain *salts of copper, of lead, or tin* derived from the condensers, in which the vapors are reduced to a fluid form. The quantity of copper salt contained in the bulk usually taken at a draught, is sufficient to produce the minor effects of metallic poisoning; the cumulative character of these poisons may even lead to fatal consequences. With a knowledge of the fact now stated, instead of resting on a supposition of the existence of an organic poison in the spirit, which may have caused sickness, the physician should notice the symptoms of metallic poisoning in persons addicted to the habit of consuming newly-distilled spirits, and interpose his aid in preventing the fatal termination of vicious indulgence."

The author goes on to remark that since he first became aware of the frequent occurrence of these metallic salts in recently manufactured spirits, he has made investigations which "prove that as all spirits at one time were new, so with few exceptions—arising from peculiar rectifications—most spirits have been, or are, more or less contaminated by metallic compounds. Old or more matured spirits have generally lost every particle of the salts once held in solution. Changes in the organic solvent have caused the deposition of the metallic compound accompanied by the organic matter from obvious sources, and in such spirits the metallic oxyd is always found—if it has been present—in the dark colored matter which has been deposited at the bottom of a cask at rest. This dark deposit has the appearance of, has been mistaken for, charcoal, detached from the charcoal staves of the casks in which the spirits have been stored. Of this dark deposit every sample has, on examination, afforded abundance of copper, copper and tin, or copper and lead, even when taken from the finer qualities of foreign spirits. Observations have been made on the nature of this change from a soluble to an insoluble state. Samples of new spirits have been kept in glass vessels until the whole metallic salt has fallen in dark flocks, leaving the clear fluid free from any metallic compound and perefectly pure. It appears therefore that matured spirits lose their poisonous impregnation during the time necessary to adapt them for use as beverages, and that while the clear, transparent fluid contains no metallic impregnation, a turbid though ripened spirit may

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prove deleterious, through its *suspended* metallic compounds. In order to avoid the poisonous effects of these salts, perfectly well-ripened and clear spirits only should be used in the preparation of medicines, and when ordered as restoratives, no new or turbid alcoholic fluids should be allowed to enter the hospital or room of the patient."

Dr. Hayes explains the origin of these salts as being connected with the production of acids, as well as alcohol in the fermenting vats. "When the wort is subjected to heat in the still, acetic, butyric and other acids rise with the vapor of alcohol, and pass into the condenser, now most commonly made of copper, with masses of solder containing lead. At the instant of condensation, these acids exert a power of corrosion on the metals quite unsuspected, and the salts formed dissolve in the spirit. Where condensers of pure tin are used, no copper salt is formed, and a little tin salt takes its place. With the vapor of dilute alcohol some vesicular vapor of the wort is carried forward, and the dextrine which can be found in the spirit; another portion of soluble organic matter is abstracted from the wood of the cask, and this is often tannic acid. In the subsequent chemical changes these organic compounds unite with the salts, and fall in the form of a sub-granular dark matter seen in colorless spirits of all kinds. In detecting the metals held in *solution*, the extract obtained, after evaporating the spirit, must be destroyed, as usual in toxicological testing, and an acid solution of the oxyd obtained; or the extract may at once be mixed with carbonate of soda, and the metal reduced by the blowpipe flame. When the deposit is the subject of trial the metal or metals appear on fluxing with carbonate of soda, in the inner flame produced by the blowpipe, on charcoal.—*Boston Medical and Surgical Journal*, lxiii, 160.

17. *Local Decomposition in Lead Aqueduct Pipes.*—Mr. J. R. Nichols of Boston calls attention to a source of danger attending the use of leaden pipes used for the conveyance of drinking water which seems to have been hitherto disregarded. Even if it be admitted that the water which is supplied to the city of Boston from Lake Cochituate, like that of most New England ponds, be such that it may be safely used after having passed through lead pipe under ordinary circumstances, it would nevertheless be wrong to infer that this water can be employed with entire safety at all points of delivery, without first inquiring whether special conditions may not exist in some localities by which the character of the water may there be changed. Having observed several instances in which the inmates of a single house had suffered from lead disease induced by the use of aqueduct water, while the inhabitants of other parts of the city supplied with water from the same original source were unaffected, and having in one instance detected the presence of considerable quantities of lead in one of the cases first mentioned, while no reaction for lead could be obtained from a specimen of the same aqueduct water taken from another locality, the author proceeded to inquire into the cause which produces this lead impregnation in certain houses or districts while the general waters of a supply remain unaffected. He has noticed in the leaden pipes removed from cess-pools, sinks and wells, that the intensity of corrosive action had been in great measure confined to the sharpest bends and depressions in the pipe, while in some instances other portions remained intact. "I

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have in my possession," he says, "a section of supply pipe, removed from the aqueduct of a neighboring city, in a portion of which corrosive action had proceeded so far as to cause leakage. The part thus acted upon was confined to an acute angle, and there is evidence to show that the plumber, in placing it in position, bent it in the wrong direction, thus creating the necessity for another turn in the opposite. This pipe had doubtless been subjected to two violent turns, which seriously impaired the homogeneity of the metal. An examination of lead pipe removed from buildings will certainly show that where there has been any perceptible amount of decomposition, it has been confined to the angles and depressions in its course. There are three causes or agencies which may perhaps be sufficient to produce these results:—1. The disturbance in the crystalline structure of the metal by bending, whereby its electrical condition is changed and voltaic action promoted, giving rise to chemical decomposition. [Together with the galvanic action which must be induced wherever connections or faucets of copper, or alloy, are fastened to the leaden pipes, or where a crack or fissure in the latter has been filled with solder. (See in this connection, an article by the Editor of the Boston Med. and Surg. Journ., xl, 125, 1849).—F. H. S.] 2. The presence of organic matter, such as fragments of leaves, and impurities pervading all pond waters, and which may be detained in angles and depressions of the pipes. Their presence, undoubtedly, promotes oxydation [?] and the protoxyd of lead will remain in solution, unless sufficient carbonic acid is furnished to change it. It is easy to conceive of conditions where this could not be the case. 3. Corrosions may be produced in lead pipes by the accidental presence of pieces of mortar. Where mortar is present, the lime would assist in oxydizing the metal, and also aid in the solution of the oxyd. Considerable portions of fresh mortar are frequently deposited in lead pipes, during the erection of buildings. When the family commence the use of the water, it holds the salts of lead in solution, and its presence may be detected for months. The process of oxydation, which is retarded or prevented altogether by the presence of neutral salts in water, could not be materially interfered with under the conditions considered. It is obvious, if these observations and conclusions are correct, that much care should be exercised in placing pipes in position in buildings. In those leading to the culinary department, angles and depressions should be avoided. Violent twists and turns should not be permitted, and during the erection of houses, the open ends of protruding pipes should be carefully closed. Assuming the general fact that lead pipes, conveying the waters of our New England ponds, become coated and protected by an insoluble lead salt, the question arises, how long before this protection is secured, or, how soon may a family commence the use of water passing through new pipes, with safety? In view of the manifest danger from local disturbances, the most sensible reply would be, *never*. A section of new lead pipe immersed in Cochituate water one hour, at a temperature of 65° F. gave a decided lead reaction with sulphydric acid. Removed and placed in six fresh portions of water one hour in each, the waters, when tested, gave similar results. The experiment continued during two weeks. Varying the time of immersion in fresh portions of water from one to ten hours the lead indications continued, although at

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last feeble. These results are sufficient to show that individuals or families should not commence the use of water flowing through new pipes, until considerable time has elapsed, and much water contact secured."—*Boston Medical and Surgical Journal*, lxiii, 149.

18. *Nature of the deposit which forms upon the copper employed in Reinsch's test for arsenic.*—LIPPERT has made a careful examination of the crust which forms upon bright metallic copper when this is placed in a solution of arsenic acidified with chlorhydric acid. This coating had been pretty generally mistaken for metallic arsenic until Fresenius (in his *Anleitung zur qualitativen Analyse*, 10*te Aufl.*, Braunschweig, 1860, p. 141,) called attention to the fact that it contained a large quantity of copper. From the experiments of Lippert it now appears that the crust in question contains only 32 per cent of arsenic, 68 per cent of its weight being copper. This composition having been nearly constant in several specimens which he analysed, Lippert maintains that the compound is a definite alloy $As\,Cu_5$. [Being evidently unaware of the experiments of Prof. Cooke, (see this Journal [2,] xx, 222) which have shown how little ground we have for believing in the existence of alloys of definite composition in the case at hand.—F. H. S.] When ignited, at the temperature of a combustion furnace, in a current of hydrogen, the compound lost only 7 per cent of its weight, an alloy of the composition $As\,Cu_6$ (same as that of the mineral Domeykite of F. Field, see this Journal [2,] xxv, 406.) being formed.

The delicacy of Reinsch's test is evidently directly referable to the large amount of copper which the characteristic coating contains, for a proportionally small quantity of arsenic is thus obtained in an enlarged and as it were more tangible, form. But on the other hand it is not easy to prove, in a simple manner, the presence of arsenic in this crust, for only a small portion of the arsenic can be volatilized in a current of hydrogen, and even if the alloy be first oxydized in a current of air and then reduced in a current of hydrogen the percentage of arsenic only falls from 32 to 20. By far the largest portion of the arsenic is therefore kept out of sight.

For the details of this interesting research and the author's discussion of the proposition of Reinsch and v. Kobell to estimate arsenic quantitatively by determining the amount of copper which dissolves while the arsenic is being precipitated we must refer to the original article.—*Journal für prakt. Chemie.* lxxxi, 168.

19. *Saponification by alkaline carbonates in the dry way.*—As an addition to the experiment of Pelouze (Ann Ch. et Phys. (3,) xlvii, 371) by which it was demonstrated several years since that soap could be prepared by heating together a mixture of fat and an anhydrous alkaline oxyd at a temperature of 250° (C.), SCHEURER-KESTNER now shows that the alkaline carbonates can be used instead of the oxyds, carbonic acid being disengaged while a true soap is formed. Thus, when a mixture of 100 parts of tallow and 22 to 25 parts of carbonate of soda is gradually heated, a lively reaction commences at about 260° (C.) [=500° (F.)], the mass swells up while an abundant evolution of gas occurs:—in order to prevent loss it is necessary to conduct the operation in a spacious retort and to moderate the heat as soon as the reaction has once begun; if in addi-

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tion to this the retort be shaken from time to time in order to mix the ingredients, which have a tendency to separate, the disengagement of gas will proceed with great regularity. Towards the close of the operation, the temperature must be slightly increased in order to decompose the last traces of the fat which is more difficultly acted upon now that it is no longer in presence of so large an excess of the carbonate. At the end of several hours a yellowish, semifluid mass is obtained which becomes more consistent on cooling; it dissolves slowly in water, producing an opaline liquor resembling in all respects a solution of common soap.

When carbonate of lime is substituted for carbonate of soda, in the proportion of 18 to 20 parts of the lime-salt to 100 pts. of tallow, the reaction occurs more readily than when carbonate of soda is employed, a slightly yellowish mass, hard enough to be pulverized, being obtained. With the carbonates of baryta, strontia and magnesia, the same reaction occurs, while with carbonate of lead, the decomposition goes on very rapidly and is accompanied with a tumultous evolution of gas.

If the action of the heat is carefully regulated, oxyd of glyceryl is alone decomposed, the fatty acids remaining intact. By direct experiment 100 pts. of tallow when saponified with carbonate of soda afforded 94·8 grms. of fatty acid; while the same amount of tallow saponified by carbonate of lime yielded 95·6 pts. of fatty acid.

100 grms. of the lime soap treated with water gave no glycerine; but by means of ether a few centigrms. of a nonvolatile oily substance, lighter than water and insoluble in alkalies or mineral acids, were extracted. The gases disengaged consist of carbonic acid, about 75·30 pr. ct., light carburetted hydrogen 11·85 pr. ct., hydrogen 12·85 pr. ct., together with a little acroleine.—*Annales de Chimie et de Physique*, [3], lx, 216.

20. *Preparation of Hydrate of Baryta by means of Oxyd of Zinc.*—Instead of the common method of preparing hydrate of baryta by decomposing sulphid of barium with black oxyd of copper, Alex. Mueller proposes to substitute commercial zinc-white for the copper oxyd. The only difference in the conduct of this, and the ordinary process consists in retaining a portion of the solution of sulphid of barium in order to precipitate some zinc oxyd which is dissolved by the baryta water. Or it might be well to decompose the last portions of the sulphid of barium with hydrate of copper (by adding sulphate of copper), since an excess of this could readily be recognized by its blue color. If by oxydation the sulphid of barium had become mixed with any of the thionic acids, the crude hydrate prepared from it should be ignited, after evaporation, with a little nitrate of baryta and the sulphate of baryta thus formed removed by filtration.—*Journal für praktische Chemie*, lxxxii, 52. F. H. S.

II. GEOLOGY.

1. Kentucky Geological Survey.—1. *Report on the Fossil Flora and of the Stratigraphical Distribution of the Coal in the Kentucky Coal Fields;* by Leo Lesquereux, Palæontological Assistant.—2. *Topographical and Geological Report of the Country along the outline base line following the western margin of the Eastern Coal field of the State of Kentucky;* by Joseph Lesley, Jr., Topographical Assistant. Large

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8vo, pp. 333–498.—These two divisions of the Report of the Kentucky Geological Survey, have reached us in advance of publication, thanks to the kind attentions of Dr. Peter, who, since the death of the lamented Owen, is charged with the publication of the work. Mr. Lesquereux here presents the results of his critical studies into the distribution of the fossil plants of the coal strata, in the various coal beds, confirming the palæontological evidence by comparative lithological sections of actual superposition. He is thus enabled to show the true relation of the strata in the different coal fields of Kentucky (as far as his observations have extended) with those of other parts of North America. This has been a great desideratum in American geology, and no observer has enjoyed greater opportunities for exact study in this line of research or has possessed in so eminent a degree the peculiar knowledge which is essential to a correct solution of the problem.

Mr. Lesquereux does not recognize the justness of the division which is often made between the upper and lower Coal measures, i. e., those above from those below the conglomerate, and sees no good reasons for calling the latter 'false coal measures.' 'If,' he says, 'it is based on the fact that the inferior coal beds are not generally found over the whole extent of the coal fields of America, the same can be said of the coal strata between the Mahoning and the Anvil Rock Sandstone, and particularly of the upper coal measures above the Anvil Rock. If this separation is made, from the thickness and extent of the great deposit of sandstone named *conglomerate*, or from its composition of coarser and more pebbly materials, the same reason for a further separation of the coal measures might be found in the thickness, extent, and composition of the Mahoning, and even of the Anvil Rock Sandstones. A separation of the inferior coal beds from the higher measures associated with them, could only be authorized by a difference in the vegetation of which the coal has been formed, and consequently in the species of plants found in the shales. But this difference does not exist, as we shall see presently. It is, therefore, more rational to take the coal measures in their whole vertical extent, as a single and inseparable formation, dividing them, for the sake of a better understanding, in four different parts.

'1. The coal measures below the conglomerate.

'2. The measures between the conglomerate and the Mahoning sandstone.

'3. Those between this last sandstone and the Anvil Rock.

'4. The upper coal measures above it, with their top still undetermined."

We take much pleasure in here reproducing, with some emendations by the author, the "Table of Comparative Sections" from the Kentucky Report, showing the comparative position of the most important coal strata in different parts of the American coal fields. The author adds:

'The number of the sections could have been much increased; but I have deemed it best to record in this table only those which I consider as perfectly reliable, and of which I have been able to compare the palæontological characters, at least at some of their principal horizons.*

* All the coal beds, the position of which has been ascertained by such palæontological evidence, are marked by a (*).

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'The remarkable analogy of distribution of the coal strata, as indicated by these sections, is thus put in evidence, and cannot be ascribed to any ideal system. The order of superposition of the different sections is established on lithological and palæontological characters. But it is only by palæontology that the equivalency of the coal strata has been, and can be, established in distant parts of the same basin, and especially in separate coal fields. Therefore palæontology, as applied to the identification of coal beds, can no longer be considered as a chimerical notion. Its practical advantage is at once evident. And I have no doubt that, as soon as it is generally received as a guide in the examination of our coal fields, the harmony of distribution of the coal strata will become more and more striking.

'The sections made in Kentucky indicate a remarkable increase in the thickness of the measures, especially of the sandstone strata towards the southeast. It would have been interesting to compare sections made in the coal fields of Virginia, south of Charlestown, and to ascertain how far this progression of thickness is continued. It was impossible to get reliable data on the distribution of the coal in that country. From what I have seen myself, many years ago, and especially from sections on Coal river, kindly communicated by Dr. I. H. Salisbury, it appears that coal No. 1, with its members B and C, and perhaps No. 2, subdivides forming as many as eight different strata. A similar development is seen in the north anthracite basin, of which Wilkesbarre is the center. In the same basin we find another analogy in the constant decreasing of the measures from Wilkesbarre to the eastern edges of the basin at Carbondale.

'It was impossible to get any well determined data from the other basins of the Anthracite coal fields. The disturbances of the strata are so marked in innumerable flexures that dynamical geology has failed, thus far, to give any indication touching the general distribution of the veins. From palæontological evidence I am satisfied that the highest coal of the Pottsville and Tamaqua basin is the equivalent of our No. 4, and that the measures do not ascend higher in that part of Pennsylvania. It is certain also that the *big* or *mammoth vein*, so generally worked in the same basin, is the equivalent of No. 1B.

'The 1st section represents the distribution of the coal strata in Union county, Kentucky, and is perfectly correct. It was made by Dr. D. Dale Owen, from borings and repeated measurements.

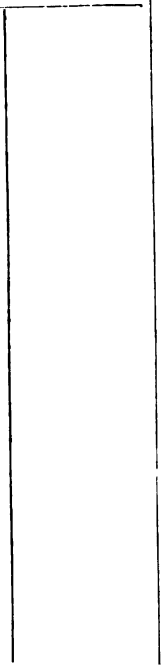
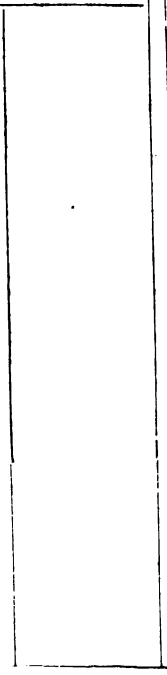
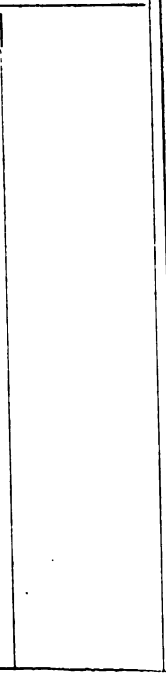
'Section 2d is the record of the Holloway boring at Henderson, and is also perfectly reliable for the place of the coal strata in this part of Kentucky.

'Section 3d is from Mr. J. P. Lesley's Manual of Coal. It was condensed from such numerous and authentic records as the best geologist can obtain.

'Section 4th is another general section of Pennsylvania copied from the final geological report of the State of Pennsylvania. In comparing these four general sections, it becomes evident that the essential coal strata, viz: coal 1B, C 4th, and C 11th, come under the same horizon. The difference in the intermediate strata is not of material importance. In the section of the Pennsylvania survey there is a distance of 480 feet marked as barren of coal, contradictory to local sections of the same Report, which

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thout reference to scale.

13. Pittston, Penn., Report 2, p. 360.	14. Scranton, Penn., Report 2, p. 339.	15. Carbondale, by Mr. E. Johnes.
		

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show generally one workable bed, the *Elklick coal*, and sometimes two, above the Mahoning Sandstone. Mr. Lesley's section has marked the place of these strata. In the same section of the report, there is a group of veins, called the Mercer coal, which has no equivalent in the other sections, or which is represented only by a thin coal. Palæontology alone can decide whether this Mercer coal is, or is not, the equivalent of No. 1B and its subdivisions, as it appears to be.

From all the local sections of the Pennsylvania Survey, two ascertained data are especially worth mentioning. 1st. The reliability of our Curlew limestone, which, in Pennsylvania, is called Freeport limestone, and is generally placed 6 to 15 feet above our No. 3 coal: 2d. The consistency of the *ferriferous* limestone between No. 1B and No. 2 in the place occupied by our coal 1C. It lies, as in Kentucky, 10 to 40 feet above No. 1B, and is generally accompanied by calcareous iron ores.

Section 5th, at Yellow creek, is given from measurements of Dr. Newberry, in his railroad survey, and from my own palæontological examination. The distances between the coal strata are said to be too great.

Section 6th was made at Buena Vista and Greenup furnaces from my own measurements, compared with five different sections, kindly furnished by Mr. John Means.

Section 7th, made at Mount Savage, is exact, as far as measurements by pocket level can be relied upon.

Section 8th was taken at West Liberty, first by Dr. D. D. Owen, and afterwards by myself. The upper part of No. 1B crops out in the bed of the river, and it was impossible to ascertain at what distance this member, one foot thick, is placed from the main 1B. The distance, 71 feet, to No. 2, is too short by, probably, 20 to 30 feet.

Section 9th, at Jackson, only shows No. 3d coal as a streak of coal 6 inches thick. The section was followed along a steep ravine, from the bed of the river to the top of the highest hill. Though this coal was covered, and its palæontology was not ascertained, I have no doubt of its identity with the Haddock's coal, our No. 3, which is worked in the vicinity, 275 feet above No. 1A.

Section 10th, at Peach Orchard, was ascertained from measurements and palæontological data. Coal 3d is only marked by a bed of hard fire clay, nearly limestone, or bastard limestone, and a streak of coal, and coal 4th is replaced by fire clay and iron ore, just at the base of the Mahoning Sandstone, which tops the hills, 520 feet above low water of Louisa river, and is conglomeratic at its top.

Section 11th, at Warfield, is made from No. 1A coal, at the top of the boring to the highest hill, 740 feet, where all the coal-strata are opened, nearly on the same vertical line. I refer the cannel coal vein, said to be 8 feet thick, to No. 3, and not to No. 4, because it is not placed just below the Mahoning Sandstone, but separated from it by about 90 feet of measures, apparently shales and iron stone. I could find no trace of coal 4th; but the top of the hill is covered, except where the Mahoning Sandstone appears in perpendicular cliffs, with a nearly impenetrable thicket of brambles, which rendered close researches impossible.

Section 12th was taken at Wilkesbarre, in the center of the north anthracite basin. This and the following sections are copied from the

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report of the Pennsylvania survey, and were especially compiled from borings and observations made by the directors of coal mines. They are entirely reliable. For Wilkesbarre, there is an upper section containing two beds of coal, which would correspond with No. 5th and 6th coals of Kentucky. As this section was not taken from the same place as the lower part, and as I could not see any of the reported coal beds so as to ascertain their palæontology, it is omitted. Some coal beds of unworkable thickness are marked in the section of the Pennsylvania report. But they are not reported by Mr. Lesley, nor were they marked in a section which I obtained of the foreman of the mines.

Section 13th, at Pittston, is remarkable by the separation of coal 2d and C. 3d, each into two beds, separated by ten feet of shales. We have seen the same disjunction of these veins at Chinch creek, and at Whetstone creek, in Greenup county.

Section 14th, at Scranton, is also reported in Mr. Lesley's Manual with some difference.

Section 15th, at Carbondale, was obtained from Mr. Ed. Jones, director of the mines of Archibald. At Carbondale the hills are too low, and contain only the coal 2d. The 3d coal is added from the Archibald's section, which is about the same. In this last place, the distance between C. 1B and 2d is 92, and at Carbondale 95 feet.

The plates illustrating this valuable memoir are not yet published.

The author in his Introductory letter takes occasion to defend himself from the charge of plagiarism made against him by the late Director of the Geological Survey of Pennsylvania in the final Report of that survey. As the alleged offence consisted in quoting the author's own report some years after it was rendered, and with full acknowledgment, it would seem hardly to fall within the requirements of a public apology.

Mr. Lesley, in his 'Topographical Geological Report,' has performed a labor of the greatest practical utility, and one heretofore quite too much neglected in our American geology. It is obvious that the processes of erosion, forming valleys on the courses of all streams, have removed certain portions of the original spread of coal. While therefore the geologist in a general map correctly colors the whole of a given area as coal-bearing, the coal owner finds to his chagrin that much of the coal which ought to be on his lands has 'gone to market.' The only remedy for such disappointments is found in accurate topographical maps in which contour lines at convenient elevations render certain what portions of the several measures remain undisturbed and what are wanting. When to the skill of the topographical engineer is added, as in Mr. Lesley's case, the special knowledge of the geologist, the results are truly valuable.

Kentucky has been fortunate in the character of her scientific corps employed in this survey, and we earnestly hope, in spite of all causes of civil disturbance, this work of peace will receive no obstruction either in its course of completion or in the publication of its results.

On a future occasion we shall return to these reports for the purpose, among other things, of considering Dr. Peter's results on the agricultural side of the survey, both in Kentucky and Arkansas.

2. *Descriptions of new fossils from the Palæozoic rocks of the Western States*, (from the transactions of the Chicago Academy of Sciences,

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October 11th, 1859*); contributed by J. H. M'Chesney. (2d extract.) —This paper contains descriptions of the following species, which are regarded by the author as new to science, viz., *Orthis Kaskaskensis*, *O. Kennecotti*, *Athyris intervarica*, *A. ultravarica*, *A. obmaxima*, *A. obvia*, *A. perinflata*, *Terebratula bisacula*, *T. subretziaforma*, *T. geniculosa*, *Rhynchonella Parvini*, *Spirifer Racinensis*, *S. clavatula*, *Rensellaeria Condoni*, *Pentamerus bisinuatus*, *P. trisinuatus*, *P. crassoradius*, *P. arcuosus*, *Ambonychia neglecta*, *Nucula obsoleta*, *Murchisonia archimedia*, *Pleurotomaria bicarinata*, *Platyceras Quinceyensis*, *Bucania crassolare*, *B. pervoluta*, *Orthoceras Laphami*, *O. Scammoni*, *O. Hoyi*, *O. lineolatum*, *O. cameolare*, *O. irregulare*, *O. nodocostatum*, *O. striælineatum*, and *Eucalyptocrinus armosus*. The last mentioned species is also illustrated by two wood cuts.

The descriptions of these fossils, although in most cases rather brief, are generally sufficient for the preliminary indication of species. In the selection of names for his species, however, the author has been in some cases rather unfortunate, several of those used having been preoccupied. For instance, Goldfuss published a *Nucula obsolata*—(Petrefact. Ger. II, p. 151). Again Sowerby published a *Pleurotomaria* under the name of *Trochus bicarinatus* in 1818 (Min. Conch., 3d, p. 39), which was referred to the proper genus by Morris in 1843. The same name (*bicarinata*) was also applied to another species of this genus by Koninck in 1843, (Ap. D'Omal. Prec. Elem. Geol. p. 517) and to still another by Munster (Goldf. Petrefact, 3d, p. 72.) The name *Orthoceras lineolatum*, was used by Phillips in 1841, (Pal. Foss., p. 111). Again the specific name *irregulare* was used by Munster for an *Orthoceras* in 1840 (Bietra. zur Petref. 3, p. 100). This criticism applies also to our author's former paper (New Palæozoic fossils,† &c.). For instance the name *Leda gibbosa* and *L. polita*, had both been preoccupied by Sowerby for recent species; and *Nucula cylindrica* was used by McCoy for a Carboniferous species in 1844 (Carb. Foss. Ireland, p. 69).

Several of the species described in these papers appear to us *very* closely allied to old and well known forms, though it is but reasonable to infer that the author's means of judging in regard to their difference or identity should be more reliable than an opinion formed from merely reading his descriptions.

* The date here given is not that at which this paper was *published*, but the date at which the paper from which it purports to have been extracted was *read* before the Chicago Academy. The copy before us was received on the 15th of Feb., 1861, which is probably as early as it was received elsewhere. We mention this fact in order to call the attention of authors to the importance of giving the date of *publication*, as well as that at which their papers were presented, where they are distributed in advance of the regular issue of the proceedings or transactions of the body before which they were read; for it must be borne in mind that it is not to the date of *presentation*, but to that of actual *publication*, (*i. e.*, general distribution amongst laborers in the department of science upon which it treats) that we must go in all cases of disputed priority. We must be excused for reiterating so frequently this important point of scientific ethics, since there still appears to be, after all that has been said, an imperfect comprehension of its force and importance.—Eds.

† See this Journal, [2], xxix, 285.

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III. BOTANY.

1. *Flora Hongkongensis: a Description of the Flowering Plants and Ferns of the Island of Hongkong;* by GEORGE BENTHAM, V.P.L.S. *With a Map of the Island. Published under the Authority of Her Majesty's Secretary of State for the Colonies.* London: Lovell Reeve. 1861. pp. 482. 8vo.—We have already noticed Harvey and Sonder's Cape Flora, and Grisebach's Flora of the British West Indies, each of which have completed a first volume. The present work is the third of this series of British Colonial Floras, upon a new and simple plan, compact in form, written in English throughout, authorized and supported by the British Government. The Colonial department pays a very moderate recompense to the authors, and turns the work over to a publisher upon such terms as to render the volume generally accessible to working botanists and colonists. This is a much wiser as well as vastly more economical plan of government patronage to scientific publication than that adopted in this country, one which secures that the publications are just what is wanted and that they reach the hands which are to use them, and not others—one which, when our present task is done and we again cultivate the arts of peace, we might profitably adopt. The present work is by a master-hand; for Mr. Bentham is one of the most experienced, industrious, and judicious of systematic botanists. The island of Hongkong has an area of scarcely thirty square miles, its general aspect is bleak and barren; yet it has already yielded about a thousand phænogamous species. "At a first glance," as the author observes, "one is struck with the very large total amount of species crowded upon so small an island, which all navigators depict as apparently so bleak and bare;—with the tropical character of the great majority of species, when botanists agree in representing the general aspect (derived from the majority of individuals) to present the features of a much more northern latitude;—with the large proportion of arborescent and shrubby species, on a rocky mass where the woods are limited to a few ravines, or short narrow valleys half monopolized by cultivation;—and with the very great diversity in the species themselves, the proportion of orders and genera to species, and the comparative number of monotypic genera, being far greater in the Hongkong Flora than in any other Flora of similar extent known to me. The very large number of endemic species,—of species known to us only from the island—is probably occasioned by our ignorance already alluded to, of the vegetation of continental South China."

A fitting acknowledgment is given for the important contribution to this Flora furnished by the botanical collection (of above 500 species) made by Charles Wright, as botanist of the U. S. North Pacific Exploring Expedition under Captains Ringgold and Rodgers, duplicates of which were obligingly and most properly furnished by direction of the Commander and the enlightened Secretary of the Smithsonian Institution.

In aid of the colonial botanists or amateurs who may use this Flora, the author has prefixed (with some minor alterations) the admirable brief outlines of Botany and Glossary prepared for his popular British Flora.

In these Outlines the subject is regarded, not from the morphological or the physiological, but from the descriptive point of view. It opens

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with a statement of the nature and design of a Flora, and of what a botanical description ought to be.

"These descriptions should be clear, concise, accurate and characteristic, so as that each one should be readily adapted to the plant it relates to, and to no other; they should be as nearly as possible arranged under natural divisions, so as to facilitate the comparison of each plant with those nearest allied to it; and they should be accompanied by an artificial key or index, by means of which the student may be guided step by step in the observation of such peculiarities, or characters, in his plant as may lead him, with the least delay, to the individual description belonging to it.

"For descriptions to be clear and readily intelligible, they should be expressed as much as possible in ordinary well-established language. But, for the purpose of accuracy, it is necessary not only to give a more precise technical meaning to many terms used more or less vaguely in common conversation, but also to introduce purely technical names for such parts of plants or forms as are of little importance except to the botanist. In the present chapter it is proposed to define such technical or technically limited terms as are made use of in these Floras.

"At the same time mathematical accuracy must not be expected. The forms and appearances assumed by plants and their parts are infinite. Names cannot be invented for all; those even that have been proposed are too numerous for ordinary memories. Many are derived from supposed resemblances to well-known forms and objects. These resemblances are differently appreciated by different persons; and the same term is not only differently applied by two different botanists, but it frequently happens that the same writer is led on different occasions to give somewhat different meanings to the same word. The botanist's endeavors should always be, on the one hand to make as near an approach to precision as circumstances will allow, and on the other hand to avoid that prolixity of detail and overloading with technical terms which tends rather to confusion than to clearness. In this he will be more or less successful. The aptness of a botanical description, like the beauty of a work of imagination, will always vary with the style and genius of the author."

These Outlines are throughout so well sketched, and so worthy to be regarded as of standard authority, that we must still venture a criticism or two, looking to their possible improvement.

In the first place, referring to paragraphs 8 and 88, we must dissent from the proposition that the subject of *homology* does not belong to "*morphology* in the proper sense of the term;"—unless, indeed, morphology relates simply to form in the lowest sense, to mere shape, arbitrarily viewed,—which would belittle the subject down to mere terminology, and empty that of all scientific interest. If the comparison even of a perfoliate or clasping with a cordate leaf, or of membranaceous or coriaceous with thickened leaves, such as those of a Houseleek, a Mesembryanthemum and an Aloë, falls within the province of morphology, surely so also must the comparison of an ordinary leaf with a cotyledon, with a bulb-scale, a bud-scale, and no less with a sepal, a petal, a carpel, &c. In the latter we merely trace morphological relations of the very same

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kind somewhat further and higher. The relation of a leaf as foliage to the scale of a bud, or to the thorn of a Barberry is clearly of the same category as its relation to a sepal or a petal,—the latter, as we regard it, bringing in no new idea, and requiring no new point of view.

Next, *Quincuncial* imbrication is defined by Mr. Bentham to be that arrangement in which "one petal is outside, an adjoining one wholly inside, the three others intermediate and overlapping on one side." But why give this name to a mixed form, to that which is merely convolute æstivation deranged by one of the five petals getting both edges under? And why change the uniform usage from De Candolle's *Théorie Élémentaire*, if not earlier, down to the present time, which defines the quincuncial mode as having two members exterior, two interior, and one with one edge overlapping its neighbor and the other overlapped;—an arrangement which especially merits a distinguishing name, since it is the normal imbrication in a pentamerous perianth, answering as it does to ⅖ phyllotaxis. So that current usage and reason tell against the innovation.

In the third place, we are equally inclined to demur to the proposed modifications of the sense of the terms *perigynous* and *epigynous* (paragr. 140), Mr. Bentham restricting the former to those cases in which the petals, &c., are adnate to a perfectly free calyx, as in the Cherry, and applying the latter in cases where the calyx, equally bearing the petals, &c., is adnate even merely to the base of the ovary, if only the adhesion reaches above the level of the insertion of the lowest ovule;—which would make most Saxifrages epigynous. Besides the etymological objections, and the inconvenience of a change, the new definitions seem to us to be at least as ambiguous as the old in practice; and it is not surprising that they are not uniformly adopted in the Hongkong Flora itself.

Finally, as to paragr. 166, we are not much better satisfied with the definition that the radicle is the "base of the future root," than with the original statement that it *is* "the future root." To us nothing in botany is clearer, or more patent to observation during germination, than that while the radicle is, if you please, "the base of the future root" inasmuch as it is that from which the root proceeds, it is itself the first internode of stem. This view, to which morphological considerations and observation of the development long since brought us, appears to be generally adopted by the French and German botanists, but not by the English. If the radicle universally failed to elongate, as in Monocotyledons, and in the Pea, Oak and others with hypogæous germination, this organ might be deemed to be merely the base of the future root; but its more usual elongation, in the manner of any other internode, plainly reveals the cauline nature which analogy would also assign to it.

The chapter on Vegetable Anatomy and Physiology is new, is very condensed, and considering that it deals with matters to which Mr. Bentham has never specially attended, is remarkably good and accurate. We merely observe in passing, of paragr. 195, 197, that the distinction between exogenous and endogenous stems, is as obvious *during* the first season, and even at its beginning, as ever afterward, and it is then that the purely systematic botanist will more commonly have occasion to examine the structure in this regard; of §198[5], that "the liber or inner bark" is

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by no means always "formed of bast cells;" of §200, that we cannot accept the statement that "in the leaf the structure of the petioles and principal ribs or veins is the same as that of the young branches of which they are ramifications," at least in any sense in which the sentence would be understood by the learner. Paragr. 207, that roots grow in length at the extremities, "in proportion as they find the requisite nutriment," might imply the popular fallacy that they grow directly by means of what they take in from the soil, which surely they do not, unless they live in the manner of *Fungi*. To say that the starch, &c., in a tuber or in a seed "*appears* to be a store of nourishment" for the early growth of the buds or the embryo, is a remarkably over-cautious statement (how could these grow without some store of elaborated matter to feed upon?): nor does the consideration that similar accumulations in the pericarps of many fruits "perish long before germination," and so do not nourish the embryo, afford to us any presumption to the contrary, even if we could not conceive—as we readily can—of other final causes, some of them important to the continuance of the species, thereby subserved.

The fourth chapter, on the Collection, Preservation, and Determination of Plants, and upon Aberrations from the ordinary type or appearance, is most excellent. A. G.

2. *Annals of the Botanical Society of Canada*, Vol. I, part I, (Dec., 1860–March, 1861), 4to, pp. 60.—This Society enters upon its career with zeal and spirit. These Annals open with the history of the Origin of the Society, and of the proceedings attending its formation, the Laws, and the Proceedings of the earliest meeting. Professor Blackie of Nashville, Tennessee contributes a medico-botanical paper upon *Cornus florida;* Mr. Schultz one upon the Botany of the Red River Settlement and the old Red River Trail; Mr. Drummond, Contributions to the local flora of Kingston, the head-quarters of the society; Mrs. Dr. Lawson, on the silk-worm and other fibre-yielding insects, and the growth of their food-plants in Canada; a note on the Hubbard Squash, by Mrs. Thomas Briggs, Jr.; what to observe in Canadian Lichens, by Dr. Lindsay; on the genus *Graphephorum* and its synonymy, by Prof. Gray of Cambridge; List of Plants collected on the Island of Anticosti and the coast of Labrador, by Mr. J. Richardson; and some other short communications. A. G.

3. *Journal of the Proceedings of the Linnæan Society*, No. 19, (1861) gives the remainder of Mitten's *Enumeration of the Hepaticæ of the East Indies*, and a good part of another of the *Præcursores ad Floram Indicam*, by Drs. Hooker and Thompson—the *Cruciferæ*. Here Dr. Hooker gives,—what was much needed,—a new distribution of the genera of *Cruciferæ*, so far as represented in India. The primary divisions, four in number, rest upon the pod, whether jointed or jointless, indehiscent or dehiscent, and in the latter, whether compressed parallel or contrary to the partition. The tribes, eleven in number, rest upon the shape of the pod, the arrangement of the seeds, and, rather subordinately, upon the cotyledons. The whole makes a much improved natural arrangement. Under *Barbarea* we are not surprised to see *B. arcuata* and *B. præcox* reduced to *B. vulgaris*, nor to see *Turritis* reduced to *Arabis*. A. G.

4. *Class-Book of Botany;* being *Outlines of the Structure, Physiology, and Classification of Plants;* with *a Flora of the United States*

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and Canada. By ALPHONSO WOOD, A.M., Principal of Female Academy, Brooklyn. New York, Barnes and Burr, &c., 1861, pp. 832, large 12mo. —This is a second and enlarged edition of the Class-Book published in the year 1845, a book which has been widely used in Botanical instruction, and which, so far as the merits of a work may be tested by the sales, must be allowed to have stood the criterion. It was natural that the author should wish to extend and improve it, and the publishers had every inducement to incite and second his endeavors. The reproduction, although designed to cover the same ground in education, is of greater pretension than the original issue. It claims a higher character, even the authority due to original investigation and competent, independent judgment. Wherefore the work invites an examination such as it would be hardly fair to apply to the former production, although in that, also, the author "distrusted every source of information except our own personal inspection," and claimed more complete, scientific, and particular acquaintance with our Flora than would have been expected. Sixteen years more of botanical study, however, should largely substantiate all similar claims. The arrangement of the page is good, and so also the choice of letter for the names which should conspicuously strike the eye, taking as it does after Dr. Chapman's book and other models. The whole appearance of the volume is commendable, or would be so if it were not seriously disfigured by clerical and typographical errors. These are annoying enough everywhere, but are especially injurous in a school-book. We know too well how misprints will lurk in a page, escaping the eye of the most attentive authors and proof-readers; but those of the present volume are beyond excuse, both for the number and the character of such blemishes. Justice to the printer constrains us to add, that for very many of them he can hardly be the responsible party. Especially must this be the case with a crowd of misspelled botanical names,—although the eyes of a competent proof-reader must have dilated with wonder that an author should uniformly write *dilitata* for *dilatata*, *pigmæa* for *pygmæa*, designate the genus *Salisburia* by the adjective name of *Salisburiana*, and the like. So also of *Simplocarpus*, *Arctostaphilos*, *thelipteroides*, which again are matched by counterpart errors in *Psylocarya* (with a species *rhyncosporoides*), *psylostachya*, *Bryzopyrum*, *rhyzophilla*, *Peplys*, *distychum*, *distychophylla*, and so on; to say nothing of *pedicillaris*, *psiticina*, *Chamæchrista*, *Crotallaria*, *precox*, *speciocissima*, *Eriophila*,—the latter transforming a lover of spring into a lover of wool! But the pupils of the Brooklyn Female Academy who can read the Greek letters in which the derivation of some of the above words is given, or who have a Latin dictionary at hand, for some of the rest, can readily be taught to make the requisite corrections.

So also we have *Limonum* for *Limonium*, *Nyctelæa* for *Nyctelea*, *Lipachys* for *Lepachys*, *Nasæa* for *Nesæa*, *Achmella* for *Acmella*, *Naumbergia* for *Naumburgia*, *Phytolacca decandria* and *Stuartia pentagynia*, and *Andromeda polyfolia* for *polifolia*, as if this specific name meant many-leaved and was a hybrid of Greek and Latin (like *leptoculmis*, p. 146). It is not so surprising that he should fall into the mistake of writing the genus *Polianthes* of Linnæus, *Polyanthes*, and so give a derivation to match, although our author might have placed some confidence in Lin-

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næus, Endlicher, &c.; and even the common books, such as Loudon, give the correct orthography and derivation.

To copy names correctly from other books, or to see that they are correctly printed, requires no high order of talent. Wherever the fault lies, there was no need to transform the connective of the anther (Latin *connectivum*) into connect*ile*, nor the name of Payer into Peyer, nor that of Duhamel into Dunham, nor that of the prince of agronomical chemists, Boussingault into Broussingault, and the familiarly cultivated ornamental plant which commemorates him into *Broussingaultia*. To justify our opinion that these are not simply errors of the press, and to give a crowning example of what bad spelling may lead one to in the end, we turn to page 292, and read:

"SEGREGATIA, Brongn. (Name referring to the *segregated* clusters of the interrupted spikes)."

Now the name in question is *Sageretia*, given in honor of M. Sageret, a distinguished French horticulturist and vegetable physiologist, as very common botanical works would have informed Prof. Wood. But having cautiously "distrusted every source of information except that of our own personal inspection," and a careless inspection of the name having led to a very queer orthographical result, and not having the original memoir of Brongniart at hand to explain the derivation, our author, it seems, could do no less than to invent one, to suit his misreading.

From the spelling (which even as to English words has some peculiarities, e. g., *Purselane* for *Purslane*), we might pass to the pronunciation, and we had marked a goodly number of names wrongly accentuated; also misapprehended etymologies. But it is not worth while to particularize them. Nor have we room now to discuss botanical points which numerously present themselves to our notice, as they would open too wide a field for remark. We freely allow that the "principle" which "has compelled" the author "to disallow the claims of many reputed species of the best authors" is applied with more probability in other cases than in the first instance the book affords, where *Sarracenia flava*, *rubra* and *Drummondii* are reduced to varieties of one species! while a leaf of one of them with a conspicuous wing is raised to equal rank, as if all three species did not produce some leaves, especially the earlier ones of the season, with a broad wing.

It is not likely that the various *new species* of the volume will bear scrutinizing. (As to a new *Senecio*, where did Prof. Wood find the specific name *anonymus?*) Some of them owe their position to misconceptions or to want of proper and needful books; and others to what looks like willful ignoring of a well-known American work, viz., Dr. Chapman's Flora of the Southern United States, published in New York in the spring of 1860, while Prof. Wood's preface bears the date of December of that year, and the edition was printed, from electrotyped plates, in the spring of the present year. Of some of these new species specimens were presented to our author by Dr. Chapman himself; as, for instance, Dr. Chapman's interesting *Goodyera quercicola*. This,—showing thereby a wonderful knowledge of the order—Prof. Wood publishes as a new *Platanthera! P.? quercicola*. As it happens, it is not a *Goodyera*, though so nearly related as to excuse Dr. Chapman in appending it to that genus;

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and Lindley published it long ago under the name of *Physurus quercetícola.*

We are curious to learn upon whose authority the leaves of *Victoria regia* are said to attain the diameter of 12 feet! We should particularly like to see *Schizæa pusilla* growing in Western New York, and trust that Mr. Timothy Wetmore will have the kindness to indicate the locality.

What can the statement mean that *Trisetum molle* (really only a luxuriant form of *T. subspicatum*) "scarcely differs" from *T. purpurascens*, Torr., which is a good *Avena*. To common eyes, no two grasses of the same tribe could be much more different. Why did not our author's "personal observation" teach him that his "*Fimbristylis distachya*, Chapman," is the same as the *Hemicarpha subsquarrosa*, on the opposite page, as Dr. Chapman was sharp enough to see before he printed his book.

We might go on a long while with such criticisms; and the introductory part would supply text for a long series of animadversions. Still we find throughout the volume evidences of much painstaking, of a genuine love for the science, and of commendable skill in smoothing the student's way to a moderate acquaintance with it, especially by means of analytical tables and keys. Well-meant endeavors should not be judged too severely; and we trust that our remarks are not over-critical or captious.

A. G.

5. *The Natural History Review, a Quarterly Journal of Biological Science*, No. I, January; II, April, 1861.—We would call attention to this new English Scientific Journal, which is published by Messrs. Williams & Norgate, London, (B. Westermann & Co., New York, being the American booksellers on the title-page*), at four shillings per number, the annual subscription twelve shillings sterling. The editors are, for Physiology and Histology, Messrs. Carpenter, McDonnell and Wright; for Systematic Zoology and Distribution, Messrs. J. Reay Greene and P. L. Sclater; for Anatomy and Embryology, Messrs. Busk, Huxley and Lubbock; for Botany, Messrs. Oliver (the promising new Professor in the London University), and Currey; for Palæontology, Messrs. Huxley and Wyville Thomson.

"In undertaking the conduct of the Natural History Review the Editors" state that they "propose to establish a Quarterly Critical Journal of Biological Science, which, without interfering with existing Scientific Periodicals, shall stand in the same relation to Naturalists and other persons interested in biological inquiries, as that which is occupied by the ordinary quarterly Reviews in respect of Men of Letters and the General Public.

"They desire, in addition, to offer to all whom it may concern, a means of discussing the general problems suggested by the progress of biological investigation in a philosophical spirit, and solely with reference to scientific considerations. The Editors will not refuse an original communication on the ground of any scientific opinion expressed in it.

"The contents of the Natural History Review will be divided into the following sections: I. Reviews; II. Original Articles and Reports; and III. Bibliographical notices and Miscellanea.

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"The first section will embrace criticisms of all important new biological works published either in this country or abroad. The second will comprise such original papers, as may be of sufficient importance to deserve publication, though they may not be of a nature to demand a place in the Transactions of a Scientific Society. Careful Reports upon the present conditions of particular branches of Natural History will form an additional important constituent of this section.

"In the third section will be comprised notices of all the Papers on biological subjects read before Scientific Societies; a bibliographical record of the various serial publications and works on Natural History that have appeared during the quarter; and, finally, miscellaneous notes.

"While the last section will form a record of the daily progress of Science, of the greatest importance to the working Naturalist, the Editors trust that the two former will contain many communications of value, not only to the man of Science, but to that large and increasing number of persons who take an interest in the results of the investigations of the professed Naturalist.

"As the wide extent of Biological Science renders it impossible for any man to be largely acquainted with more than two or three of its branches, the Editors have divided the labor of collecting and supervising the requisite materials according to the scheme which heads this prospectus; but they do not hold themselves responsible for the opinions expressed in articles to which their names are not attached, and they particularly request that all communications intended for the Journal may be addressed to the Publishers, the words 'Natural History Review' being written upon the outside cover."

The *Reviews* in the first number are, 1. Of the *Flora Brasiliensis* of Von Martius,—in which we discern the hand of one of the best botanists of our time;—2. Berkeley's *Outlines of British Fungology*;—3. *The Mammals of Amoorland*; Leydig's *Natural History of the Daphnidæ*, reviewed by Mr. Lubbock; *On the Natural* Position of the Group *Protozoa*, a review of several recent works relating to or touching upon these simple organisms. The *Original Articles* are one by Mr. Lubbock *On Spærularia Bombi*; one by Dr. McDonnell *On an Organ which in the Skate appears to be the Homologue of the Electrical Organ of the Torpedo*; by Mr. Wright, *Notes the Anatomy of the Alimentary System of the Axoloil* (*Siredon Mexicanum*); and finally, one which has naturally attracted unusual attention, by Prof. Huxley, "*On the Zoological Relations of Man with the Lower Animals.*"

Of No. II, the *Reviews* are on Prichard's *History of Infusoria*, fourth edition; and on the *Primitiæ Flora Amurensis*. The *Original Articles* are one *On the Species and Genera of Plants, considered with reference to their practical application to Systematic Botany*, by George Bentham,—an article full of wisdom. *On the Serial Homologies of the Articular Surfaces of the Mammalian Axis, Atlas, and Occipital Bone*, by Dr. John Cleland. *On the Crania of the most Ancient Races of Men*, by Prof. Schaafhausen of Bonn (from Müller's Archiv, 1858), *with Remarks, and Original Figures taken from a Cast of the Kanderthal Cranium*, by George Busk;—an extremely interesting article. *The Sensory and Motor Functions of Nerves*, by G. H. Lewes. *General Results of the Study of the Typical Forms of Foraminifera*, &c., by Dr. Wm. B. Car-

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penter—particularly interesting, as are other articles in this and the former number, on account of the manner in which the subject is treated in relation to the Darwinian hypothesis. *On the Affinities of the Brain of the Orang Utang*, by Dr. Rolleston, the new Linacre Professor of Anatomy at Oxford; a well-considered and every way most admirable communication. Analysis of or comments on these articles would be here out of place.

The *Bibliographical Record* occupies about 36 pages in each number. It will be very useful. This periodical was much wanted. It challenges attention; and deserves, and we hope will receive, a larger support than has usually been given to British Scientific Journals of a high order.

IV. ASTRONOMY AND METEOROLOGY.

1. *The recently discovered Asteroids.*—For convenience of reference, we place on record a summary of the asteroids discovered since 1858.

(57) Mnemosyne, discovered on the evening of Sept. 22, 1859, by Dr. R. Luther of Bilk. Its brightness is that of a star of the 10th magnitude.

(58) Concordia, discovered March 24, 1860, by Dr. Luther of Bilk. Its brightness is that of a star of the eleventh magnitude.

(59) ———, discovered Sept. 12, 1860, by M. Chacornac at Paris. Its brightness is that of a star of 9th to 10th magnitude, and this is the sixth planet discovered by M. Chacornac.

(60) Danaë, first seen Sept. 9th, 1860, by M. Goldschmidt of Paris, and recognized as a planet Sept. 19th. Its brightness is equal to a star of the 11th magnitude.

(61) Titania, discovered by Mr. Ferguson, at Washington, on the night of Sept. 15th, 1860. It appears as a star of the 11th magnitude.

(62) Erato, discovered at Berlin by Dr. Förster and M. Lesser. First observed Sept. 14th, 1860, but supposed to be Chacornac's planet (59). The continuation of the observations up to Oct. 10th, showed that this was a distinct planet. Its brightness is that of a star of the 11th or 12th magnitude.

(63) Ausonia, discovered at Naples, by M. De Gasparis, Feb. 10th, 1861. It appears as a star of the 10th magnitude, and is the eighth planet discovered by M. De Gasparis.

(64) Angelina, discovered at Marseilles, by M. Tempel, March 2, 1861.

(65) Maximiliana, discovered at Marseilles, by M. Tempel, March 4th, 1861.

(66) Maia, discovered at Cambridge, Mass., by Mr. H. P. Tuttle, April 9th, 1861. It appears as a star of the 13th magnitude.

(67) Asia, discovered at Madras, India, by Mr. N. R. Pogson, April 17, 1861. It appeared as a star between the 11th and 12th magnitudes, and this is the fourth planet discovered by Mr. Pogson.

(68) Leto, discovered at Bilk, Germany, by Dr. Luther, April 29th, 1861. It appeared as a star of the 11th magnitude. This is the tenth planet first discovered by Dr. Luther.

(69) Hesperia, discovered at Milan, by Sr. Schiaparelli, April 29th, 1861. It appeared as a star of the 11th magnitude.

(70) Panopea, discovered at Paris by M. Goldschmidt, May 5, 1861. It was between the 10th and 11th magnitudes. This is the fourteenth planet discovered by M. Goldschmidt.

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We append the elements of several of these planets, according to the most recent computations:

Berlin mean time.	(57) Mnemosyne 1860, Jan. 1·0.	(58) Concordia, 1860. Jan. 0·0.	(59) ——— 1860, Oct. 0·0.	(60) Pandora, 1860, Sept. 29·0
L	28° 35′ 25″·6	162° 16′ 26″·9	9° 19′ 40″·1	345° 42′ 33″·8
ϖ	52 53 13 ·0	177 55 57 ·8	18 56 24 ·4	340 8 37 ·7
Ω	200 5 25 ·1	161 21 35 ·7	170 18 54 ·6	334 19 6 ·5
i	15 8 1 ·6	5 2 57 ·8	8 36 50 ·1	18 17 1 ·0
e	0·104116	0·040091	0·118840	0·163084
μ	632″·4633	802″·9694	793″·561	691″·58794
a	3·157288	2·692806	2·714047	2·974675

Berlin mean time.	(61) Titania, 1860, Oct. 1·0.	(62) Erato, 1860, Sept. 24·0	(63) Ausonia, 1861, March 9·0.	(64) Angelina, 1861, April 0·0.
L	355° 30′ 17″·1	5° 1′ 31″·7	178° 35′ 2″·9	170° 42′ 16″·7
ϖ	158 5 38 ·6	40 11 41 ·3	272 54 41 ·9	126 28 10 ·5
Ω	187 12 10 ·3	126 57 24 ·5	338 9 23 ·8	311 2 28 ·4
i	4 41 4 ·4	2 14 55 ·3	5 56 23 ·7	1 19 40 ·0
e	0·198641	0·165012	0·131550	0·124830
μ	1024″·1465	636″·320	953″·156	809″·508
a	2·28962	3·14452	2·40194	2·67828

Berlin mean time.	(65) Maximiliana, 1861, March 18·5.	(66) Maia, 1861, May 16·6.
L	194° 15′ 24″·1	183° 21′ 17″·6
ϖ	254 37 32 ·0	43 54 5 ·7
Ω	159 9 11 ·9	8 11 41 ·7
i	3 29 14 ·1	3 4 8 ·8
e	0·140705	0·154229
μ	553″·149	820″·71
a	3·45231	2 65387

In the above tables,

L represents the mean longitude of the planet at Epoch.

ϖ " the longitude of the perihelion.

Ω " the longitude of the ascending node.

i " the inclination of the orbit to the ecliptic.

e " the eccentricity of the orbit.

μ " the mean daily motion.

a " the semi-major axis of the orbit.

Comparing these elements with those of the asteroids previously discovered, we find a large range in the dimensions and positions of the orbits. The asteroid which is nearest the sun is Flora, (mean distance 2·20) with a period of 1193 days. The asteroid most remote from the sun is Maximiliana (mean distance 3·45) with a period of 2343 days; so that the extreme asteroids differ more between themselves, than the orbit of the earth does from that of Venus or Mars.

The asteroid whose orbit has the least eccentricity is Concordia (eccentricity 0·04); that which has the greatest eccentricity is Polyhymnia (eccentricity 0·337). The orbit of Faye's comet has an eccentricity of only 0·556; so that in respect of eccentricity, the asteroids differ more among themselves than they do from the comets.

The asteroid whose orbit is least inclined to the ecliptic is Massillia (inclination 0° 41′); that whose orbit is most inclined to the ecliptic is Pallas (inclination 34° 42′).

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Of the 66 asteroids whose orbits have been computed, 16 have their ascending node in the first quadrant; 24 in the second quadrant; 14 in the third quadrant; and 12 in the fourth quadrant; showing but a slight tendency towards that position of the orbits which the theory of Olbers requires.

2. *The Comet discovered by Mr. Thatcher.*—On the evening of April 4th, 1861, a comet was discovered by Mr. Albert E. Thatcher, an amateur observer in the city of New York. The discovery was made with a telescope of 6 feet focus, and 4½ inches aperture, made by Mr. Fitz. The comet was found in the head of Draco, in R. A. about $17^h\ 33^m$ and N. Dec. 56°. On the morning of April 6th, Mr. Thatcher reported the discovery to Mr. Fitz, and on the evening of the same day Mr. Fitz found it with a comet seeker of 7½ inches aperture; after which he went to Mr. Rutherford's observatory, and found it with Mr. Rutherford's telescope. The comet was nearly circular. Its diameter was about 2′, and it was somewhat condensed at the centre. Its place at 13^h sidereal time, April 6th, as determined by Mr. Rutherford, was A. R. $17^h\ 24^m\ 59^s{\cdot}3$; Dec. 56° 42′ 57″ N. The place of the comet was determined again at the same observatory, April 7th, 9th, 10th, 20th, 26th, etc. On the 10th of April, the brightness of the comet had increased, the nucleus was ill defined, and its diameter about 5′. April 26th the comet was visible to the naked eye, was nearly circular in form, and about 6′ in diameter. Throughout most of the month of May, the comet was visible to the naked eye as a star of the third magnitude.

At the Washington observatory, the comet was observed April 10th, at $10^h\ 10^m\ 20^s{\cdot}6$ mean time, in R. A. $17^h\ 7^m\ 56^s{\cdot}71$, Dec. + 59° 26′ 13″·53. At the Cambridge Observatory the comet was also observed April 10th, 11th, 14th, 18th and onward.

The comet was seen in London by Mr. Parkin, April 29th, and on the night of May 1st with the naked eye.

The monthly notices of the Royal Astronomical Society, published May 13th, contain the announcement of the discovery of this comet by Mr. Thatcher, but without any intimation of its having been seen in any part of Europe before the 29th of April. It is presumed therefore that Mr. Thatcher was the first discoverer of this body.

The elements of this comet have been computed from the Cambridge observations of April 10th, 18th and 29th by Mr. T. H. Safford, assistant at the Cambridge Observatory, as follows:

T.	1861. June 2·8672 m. t. Washington.		
log. q.	9·96488		
$\pi - \Omega$	213°	2′·70	Mean eq. 1861·0.
Ω	29	47 ·45	
i	80	2 ·62	

Motion direct.

The preceding elements do not bear any very close resemblance to those of any comet hitherto observed. According to these elements, the comet on the 11th of May passed so near the earth's orbit as to include it in its atmosphere; the comet's distance from the earth being at that time about thirty-six millions of miles.

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3. *On the Algebraical and numerical theory of errors of observations and the combination of observations.* By GEORGE BIDDELL AIRY, M.A., Astronomer Royal of Great Britain. London, 1861. 12mo, 120 pages. —The object of this short treatise is to determine the probable error of the mean of any number of measures of a physical element, together with the most advantageous mode of combining such observations. The conclusions of Mr. Airy differ somewhat from those which for some years past have been extensively adopted by men of science. Legendre demonstrated that when it is required to determine the values of several quantities from a large number of simple equations, the most probable values of the unknown quantities are those which render the sum of the squares of all the errors the least possible. This method, which is called *the method of least squares* has been very generally adopted by men of science throughout the continent of Europe, and also in this country. The result of Mr. Airy's investigation is that the observations should be combined by multiplying each measure by a number which is called the "combination weight;" that we should add together these products of measures by combination weights; and divide the sum by the sum of combination weights. With respect to that combination-weight which is most advantageous, Mr. Airy concludes that that combination is best which gives a result whose probable error is the smallest possible. It is then necessary to determine the value of the probable error in each of the observations. Frequently this cannot be done by any simple rule, because the observations are not all alike. The determination of the value of this probable error must rest very much with the judgment of the observer. Mr. Airy adds "the reader must not be startled at our referring these decisions to his judgment, without material assistance from the calculus. The calculus is, after all, a mere tool by which the decisions of the mind are worked out with accuracy, but which must be directed by the mind."

METEOROLOGY—

[We present herewith abstracts of several important papers by Director W. Haidinger of Vienna on the subject of meteoric falls in which will be found many new and important views both physical and mineralogical lately announced by this distinguished author:]

1. *Hraschina near Agram.**—One of the most interesting falls of meteorites and for a long time the only one of metallic iron, which had been *witnessed* is that of Hraschina near Agram, May 26th, 1751. It is noticed in Prof. W. S. Clark's paper on metallic meteorites, (Am. Journ. of Sci., 2d Ser., vol. xv, page 15). W. Haidinger at the meeting of the Imp. Acad. of Vienna of April 14th, 1859, produced the Latin document referring to it (which never had been published) and the original German translation; also a *second* document accompanied by two pictured plates, representing the phenomenon as observed at Szigetvár (or Gross-Sziget), 75 miles E. of Hraschina, a paper lately discovered in the Imperial Cabinet of minerals at Vienna. At the meeting of Febr. 3d, 1860, he presented a *third* document, which had been discovered in the archiepiscopal library at Agram, describing the phenomenon as seen at Biscupecz near Warasdin, 17½ miles north, a little towards East of Hraschina.

* *Der Meteoreisenfall von Hraschina bei Agram am 26. Mai, 1751, von* W. HAIDINGER, *Wien, 1859, mit 1 chromolithogr. Tafl.*

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These various documents give some data and explain some relations, which heretofore were doubtful and contradictory.

The meteor, which fell on May 26, 1751, between 6 and 7 P. M., west of Szigetvár (or Gross-Sziget) was at that place first observed as a flash of light *without* any noise, immediately after, it appeared like a flame resembling a tortuous chain, extending directly toward the west and terminating, in the middle height of the air, in a "fireball," which left behind a long tail. On its arrival in the lower strata of the air it appeared like a sparkling fireball of enormous size with a tortuous chainlike tail in the higher regions, the last traces of which faded away at about 10 o'clock P. M. At Biskupecz it was observed as a small cloud, from which some noise was emanating, and which afterwards disappeared.

Two pieces of iron fell a little east of Hraschina, one of 71 pounds, penetrating the ground to a depth of four feet and six inches (not 18 feet as generally stated, owing to an erroneous translation of "ad tres cubitos") and at present preserved in the Imp. cabinet of Vienna, the other of 16 pounds, which had been distributed partly at the place of its fall and afterwards at Pressburgh, and of which every vestige is lost. From the computations of various observations of the meteor it appears that it passed from Neustadt to Hraschina or from north to south from 48° 35′ to 40° 0′ 2″, and from west to east from 28° 18′ to 34° east of Ferro, which requires a motion of the earth 22·8 minutes, until the western meridian occupies the place of the eastern. We have no observation with regard to the velocity of this fireball, but its height just before its fall at Hraschina, as viewed from Szigetvár was between 30° and 35°, equal to an altitude of 43 to 52·5 miles.

Another consideration is very important. The planetary velocity, with which the meteorite entered our atmosphere and remained at about the same height between Neustadt and Hraschina, was checked a little east of the latter place, where the fall suddenly begun. The resistance of the air alone could have produced this result, a gradual preponderance of the attraction of the earth would have produced in the path of the meteor a far less sharp angle, than that at Hraschina.

Prof. H. calls attention to another matter of great interest, the vast difference between the apparent size of the meteor and its solid contents. A body of 15 inches in diameter at a distance of 75 miles is invisible, yet, the meteor is pictured as if of the size of the sun. The appearance of the chain indicates the time when the solid portions became visible, they are undoubtedly however only the paths of the luminous bodies, and, that they do not form straight lines, is very natural, if we take into consideration, the flat shape of the meteorite, which, by its rapid passage, must have been tossed from one side to the other by the resistance of the air. If the rapid compression of the air is sufficient to annul the cosmical velocity, it certainly can produce the elimination of light, the fiery phenomena. These two points established, as a natural consequence of the same cause, two other phenomena result, which belong to the character of fiery meteors. The solid nucleus of a meteor is not a globe, it passes undoubtedly through the resisting medium, with its centre of gravity foremost, producing at the same time, on account of the unequal distribution, a rotation of its mass, which increases in rapidity, whilst the velocity of the motion diminishes in a direct ratio. We can readily conceive there-

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fore, that this rotation can easily produce the bursting of an unequally heated stony mass, coming from a space whose temperature is −50° to −90° C., when heated in a few seconds from its outside red-hot by the compressed air. The rotation would be sufficient also to put the surrounding strata of the air in a whirling motion, the air compressed to such an extent, that it becomes luminous, would by the rotation of the nucleus be driven out tangentially along its globular surface, re-uniting again behind it, where a vacuum had been formed. The fireballs are only visible at a distance, close by only the black stones. In accordance with the above suggested powerful rotation is the breaking asunder of the flat mass in two pieces of 71 and 16 pounds respectively, by the centrifugal power.

The report of the explosion of the Hraschina meteor was heard as far as Warasdin, which would give, taking Hraschina as the centre, an area of nearly 1000 square miles, over which the sound was audible.

In opposition to Chladni's theory, that the explosions of meteors are produced from the centre towards the outside by the bursting of a tough envelope filled with gas, Haidinger suggests a far more simple and natural explanation. Taking into consideration that the meteorites arrive as frequently highly crystalline solids and that they produce their fiery envelope (a real photosphere) during their passage with planetary velocity through our own atmosphere by the condensation of the air before them and the pushing away of the same in all directions perpendicular to their orbit, thus obtaining a rotary motion, by which in the interior of the fireballs a vacuum is produced, there is a possibility that, when the meteor enters the denser strata of our atmosphere, where its velocity is checked or its motion completely stopped, the empty space is suddenly filled by the surrounding air and *thus* the sound produced.

The Hraschina iron was the first, in which the highly crystalline structure of meteoric irons was observed, and Haidinger gives an interesting account of the circumstances, under which this discovery was made. Alois von Widmannstätten, a highly educated and thorough iron master, had a plate of the mass cut off $1\frac{3}{4}$ by 1 inches in size and $\frac{3}{16}$ of an ounce in weight, which he had carefully polished for the purpose of examining its behavior, when exposed to heating. But what a surprise! After the color of the principal mass had passed through the various shades of straw-yellow, brownish yellow and violet into blue, there remained groups of regular triangles of straw-color parallel lines, the blue and violet intervals $\frac{1}{2}$ to $\frac{1}{4}$ line wide, the straw-yellow lines $\frac{1}{8}$ to $\frac{1}{4}$ of this width, in reality, a splendid phenomenon. This was the first observation, and the figures were called "Widmannstätten's figures" in honor of their discoverer. The method, generally in use at present, the etching by acids, was introduced immediately after this discovery.

2. *Leitform*—Or the typical form of Meteorites.*—In a paper on a typical form of meteorites presented at the meeting of the Imp. Acad. of Vienna on the 19th of April, 1860, Director Haidinger suggests some new and very interesting ideas. The paper is accompanied by two plates, representing the appearance of meteoric stones from Stannern and Gross-

* *Eine Leitform der Meteoriten von* W. Haidinger, 1860, *mit 2 Tafeln.*

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Divina which are complete in themselves and may be considered as individuals of their kind, which at the same time show distinctly one of the periods through which they have pased.

In viewing meteorites we necessarily must start from certain fundamental considerations, proved by the phenomena themselves in order to arrive at a full understanding of their forms and conditions. These are: 1st, the stone leaves the extra-terrestrial space as a solid; 2d, its velocity is greatest on entering the atmosphere of our earth; 3d, it is retarded by the resistance of the air; 4th, the "fireball" (or luminous envelope of the meteor) is formed by the compression of the air and the rotation of the stone resulting therefrom; 5th, the termination of the first part of the path is marked by a detonation, the so-called "explosion," the vacuum inside of the fireball being suddenly filled by the surrounding air.

The crust is formed during the first part of the phenomenon by a rapid melting. The Stannern stone passed through the atmosphere with its rounded side foremost, which shows over its whole surface reticulated sulcations, resulting from the uniform action of the resisting atmosphere upon it, whilst the crust was in a viscous state. The lustrous crust is surrounded by a protruding gibbosity; the stone had formerly sharp edges, which however in the foremost direction of the meteorite were melted off and rounded and blown off towards the back part of the same.

The time of the passage through the atmosphere up to that of the detonation is very short, and generally lasts only a few seconds. The rising temperature, which produces the crust, belongs altogether to this period, since the stone came from the planetary space with a temperature of perhaps 100° C. below the freezing point. According to the greater or less conducting power of their constituents, meteorites will be heated more or less rapidly; masses of iron for instance may get red hot, whilst those, composed of bad conductors, remain cold inside, and, as soon as the influence of the heating ceases, or in other words, as soon as the detonation has taken place and the "fireball" disappeared, the inside and outside temperatures of the meteorite are soon counterbalanced and the crust is rapidly cooled, especially on account of the detonation taking place at a height, where the temperature is generally very low.

Masses like those of the Cape meteorites of 13th Oct. 1838, are probably the worst conductors of heat amongst the meteorites. They also have a crust very similar to that of Stannern, even in some spots the reticulated delineations on their "heads," but the crust is very superficial and the interior mass contains a considerable quantity of water of composition which can be expelled only at red heat.

During the real fall of the meteorite or after it already belongs to our planet, its velocity is, comparatively speaking, so inconsiderable, that a re-melting of its crust is improbable if not impossible.

From the form of the Stannern meteorite, the position of its crust and especially the protuberance, it becomes evident that the reticulated surface must have passed foremost during its passage through the atmosphere, and has formed the "head" of the same. Its centre of gravity, which always must be foremost in space, lies near that point. It could rotate on the axis of its path but could not be irregularly overturned. From its form we learn another fact; the stone did not burst in our atmosphere but

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it came from the planetary space of its present size, excepting that portion perhaps, which may have been melted off. It shows the result of a single uniformly progressive period in the formation of its surface and requires us to adopt a modification of our present views about the fall of meteorites. Certainly it is not always *one* meteor, which "explodes," and the fragments of which fall down as meteorites, but in many instances *whole swarms* of separate pieces enter our atmosphere, forming one common fireball, the bursting of which may be caused by rotation, and the separate detonations belong doubtless to the different individuals, brought to a stand-still.

The stone of Gross-Divina, which in its general character is allied to those of Timochin, Zebrak and Eichstädt, shows a great dissimilarity on its two principal planes, one being pretty smooth, the other very rough. The form of the whole stone is that of a fragment, altered only on its surface. Characteristic of this meteorite is a ridge, which passes over the "head" of it, and on account of which it had, whilst passing through the atmosphere with planetary velocity, alternately two different positions, first one plane foremost and then tilting over to the other. A large surface of nearly 80 square-inches compresses the air, and surrounds the cold stone with a "fireball," the flaming points of which, uniting immediately behind the stone, where we can imagine the greatest rarefaction of air, have the most favorable position to melt off the surface and produce the roundish spots resulting from their attack.

Corresponding with the ridge over the frontpart (or head) is one over the back part of this meteorite, as the boundary of the action of the two positions of it, produced by alternately tilting over from one side to the other on its cosmical path through the atmosphere. The roundish spots, where a melting off has commenced, have a striking resemblance to the impressions of fingers in dough, and have been frequently called "impressions" (Haidinger prefers the name "depressions"), and we can often learn the position of the stone during its cosmical course by a careful examination of their situation. We find them generally on that side of the meteorite best protected during its passage.

What is most remarkable in the foregoing is the fact that some of the meteorites have retained their equilibrium during the first period of their passage through the atmosphere.

[One fact in the physical history of meteorites seems not to be fully explained by the theory of Dir. Haidinger that the production of a crust appears impossible after the body reaches our atmosphere and explodes—namely that there is often a face of recent fracture plainly distinguishable from the older and more rounded faces by its general aspect and still more so by the extreme thinness of the crust over this newly exposed face. Such faces are visible on the New Concord (Guernsey County) Meteors of May 1st, 1860. It would seem to follow from Haidinger's reasoning that sometimes at least meteors should reach the earth having faces of fracture unglazed by any crust. Such in fact is the case in the *Quenggouk* meteor described on page 142. But this is a very rare if not an unexampled occurrence. We seem therefore driven to the conclusion that in the brief interval between the explosion and the body's coming to the earth (its *telluric period*) a new crust is sometimes formed over the freshly fractured surface.—s.]

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3. *St. Denis-Westrem.**—At the meeting of the Imp. Acad. of Vienna of October 4th, 1860, Director Haidinger gives an account of the meteorite of St. Denis-Westrem.

The fall took place *without* detonation and accompanied only by slight noise, similar to the rattling of carriages, on June 7th, 1855, 7¾ P. M. near the town of St. Denis-Westrem, about 2½ miles from Ghent in Belgium. It fell about 30 paces from a man and woman. It penetrated the ground about two feet and was immediately dug up; it was still hot, blueish black and smelled sulphurous. It weighed 700·5 grammes, its sp. gr. = 3·293.

Its form is very remarkable, similar in shape to an "Ananchites," (a genus of Echinus,) a flat elongated base and an arched inclosure. It has the character of a real fragment and is incrusted all over. The crust on one side is very uneven, whilst the other portion is more even and equally rounded, especially on the edges. The edges between the rough surface and the rounded planes are well marked.

The centre of gravity foremost indicates the direction of the motion, which is also confirmed by the rounded, though not very marked, depressions on the opposite side. The position may indicate that the rotation has been exceedingly influential in rounding it by melting off the outermost inclosure. The fusibility, however, must be very trifling, the crust being very thin and of very little lustre.

The absence of a detonation in this case as well as at Linum near Fehrbellin (Sept. 5th, 1854), only represented by some rattling, blustering or hissing, when compared with the tremendous sounds and roaring, such as occurred at New Concord for instance, is worthy of our fullest attention. The size of the meteorites seems to have nothing to do with it. Every one has an independent motion through space, until, after being exposed to a series of various conditions within a space filled in its centre by our earth, it finally becomes a part of the same. The earth itself has a rapid motion round the sun, every point of its surface one corresponding with the daily rotation round its own axis. It certainly can occur that a meteorite rushes from space tangentially upon the orbit of the earth with a velocity of little more or less of 20·5 miles in a second, in which case the meteorite overtakes the earth or is overtaken in its course thereby, and this at such a distance that it is then really attracted by it and must finally reach it according to the laws of gravitation. It might be possible in an extreme case that on account of the absence of the compression of air, no crust would be formed. But this being present both on this meteorite and that of Linum, there may have been a lesser degree of compression of the air but not a total absence of it. At the same time, however, the resistance in the rotation of the atmosphere may have its influence, which can act in opposition to the rotation of the meteorite round its own axis.

The stone resembles those of Reichenbach's 2d family, "somewhat blueish stones," Slobodka, Château-Renard, Lissa, etc., and especially that of New Concord, Ohio.

The stone contains finely disseminated iron and pyrrhotine, the latter sometimes filling up vein fissures, which give it the character of a fragment from a very large mass, a real mountain of rock.

Disseminated through the whole mass are spots of so called ironrust

* *Der Meteorite von St. Denis-Westrem im k. k. Hof. Mineralien-Cabinete von* W. Haidinger. 1860 (*Oct.*).

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and globules, somewhat crystalline in their cross-fracture, which leave impressions when falling out of the brittle mass.

4. *Calcutta Meteorites.**—At the meetings of the Imp. Acad. of Vienna of June 8th, November 8d, and the last one of the year 1860, W. Haidinger has given some accounts of the "Calcutta Meteorites," which had been acquired a short time before by the Imperial cabinet of minerals, of which we give the following abstracts.

(1.) The Meteorite of *Shalka* (or Shaluka) in Bancoorah fell about 80 yards south of the village in a rice-field on the 30th Nov., 1850, three hours before sunrise. The fall was witnessed by two persons. The noise, compared with thunder, although peculiar in its nature and by the natives called "gurgur," "charchar purpur," was hardly very loud, because it did not wake up the inhabitants of Bhora ¾ of a mile distant. The stone had penetrated the ground to a depth of about 4 feet, by digging for it fragments were found to the depth of three feet and in a circle of about 20 feet radius. It appears that only *one* stone fell, which, however, was broken into fragments by striking the ground, and it may have been three feet long. It came from a southerly direction at an angle of about 80°. It must have been hot, when it fell, the black crust here and there peeled off and stuck to the earth in small fragments; the surrounding earth had the appearance of burnt clay.

The stone is very peculiar, the fine grained portion of a whitish color resembles pumice, the darker ash-colored crystalline portion forming coarsely grained aggregations of individuals of two lines in every direction, have the appearance of pearlstone, the latter forming globular masses of several inches in diameter, inclosed in the former or penetrated by it in a veinlike manner, the whole mass having the appearance of a breccia. It is friable like coccolite. The larger individuals show a distinct cleavage in one direction, less so in another, intersecting at angles of 100° and 80°; perpendicular upon them terminations are sometimes met with, which can be considered as planes of crystals and parallel of which no cleavage is observable; twin composition parallel with one of the prismatic planes. The *real* fracture shows greasy lustre. The mass is extremely friable and fragile; H. = 6·5; Sp. gr. at 19° R. = 3·412.

Small grains up to the size of a millet-seed of chromic iron, sometimes in octahedral crystals are intermixed with the ash-colored mass. The dull blackish brown crust is not thicker than writing paper; here and there it forms irregular reticulated particles, which show somewhat more lustre.

It does not contain any metallic iron. The grey mass contained according to K. von Hauer:

Silicic acid,	= 57·66		= 30·50
Alumina,	= *trace*		
Oxyd of Iron,	= 20·65	= 4·58	
Lime,	= 1·53	= 0·48	= 12 61
Magnesia,	= 19·00	= 7·60	

and stands in the middle between the bi- and tri-silicates of monoxyds, the oxygen ratio being = 1 : 2·42. It is named by Haidinger in honor to the late Henry Piddington, and resembles in composition an olivine-like mineral, (alleged to have come from the meteoric iron of Grimma) and Shepard's Chladnite.

* Die Calcutta-Meteorite, von Shalka, Futtehpore, Pegu, Assam, und Segowlee im k. k. Hof Mineralien-Cabinete von W. Haidinger.

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The Shalka meteorite belongs to Reichenbach's first family (?) first group and Shepard's Chladnitic-trachytic stones.

(2.) An interesting fall of meteorites occurred on December 27th, 1857, 25 minutes after 2 A. M., at *Quenggouk* near *Bassein* in Pegu. Three stones, which were evidently fragments of *one* meteorite, we found five and ten miles apart. According to the information, which Haidinger received from Mr. Oldham, the meteor, which emitted the stones had the appearance of a large inverted umbrella in flames, as observed 90 miles south of Quenggouk on the river Bassein, passing from W. to E. at an altitude of 40° to 50°, and after the termination of its path giving a report like that of a monster gun, followed by a rumbling noise. Another observation made on board of the steam-frigate Semiramis about 200 miles S.E. from where it fell, describes it as having had at first the appearance of a large star, rapidly increasing in size until it was about three times as large as the moon, leaving behind a long tail and falling toward the east.

From these observations Haidinger made the following deductions: 1st, the height of the meteor was from 80 to 120 miles (16 bis 24 meilen); 2d, the original cosmical course was E.N.E. to W.S.W., the latter part of it, however, from W. to E. this change being caused by the resistance of the atmosphere; 3d, the size of the meteor was, if the word *three times* is referred to the area of the moon, 14,400 feet, if to its diameter, 24,000 feet; 4th, the pieces found between five and ten miles were thrown asunder by a real explosion, produced by the rotation of the meteor; 5th, the pieces were real fragments, which fitted together and the fracture planes of which were not covered by a crust, a proof that the telluric fall did not take place with cosmic velocity; 6th, the detonation was heard at 100 miles distance but not at 200 miles.

(3.) Another fall, on which Mr. Oldham reported to Haidinger, took place at $2^h\ 14^m$ P. M., on July 14th, 1860, at *Dhurmsala in Punjab*, and was accompanied by a tremendous noise and a great number of detonations, similar to those of the discharge of heavy artillery. The earth was shaken in convulsions and trembled. Three witnesses saw a flame of two feet broad and nine feet long, passing obliquely over the station after the first explosion had already occurred. The direction is stated as N.N.W. to S.S.E. and stones were found at five different places in this direction; it is said that stones had also fallen at several other localities.

They penetrated the ground to a depth of from 1 to 1½ feet, and it is reported that persons, who picked up some fragments, before they held them in their hands half a minute, dropped them again, owing to the intensity of cold which quite benumbed their fingers. The largest piece found weighed 320 lbs. The observation of the intensity of cold of the fragments is a matter of great interest and importance. The little meteorite passes in its cosmical path during an incalculable period through an excessively cold space. By the resistance of the atmosphere, light and heat are developed, which latter might even produce a melting of the surface of bad conductors, whilst the inside of it remains quite cold.

(4.) The fall of the meteorites at *Futtehpore*, Nov. 30th, 1822, has already been mentioned by Prof. Shepard (this Journal, 2d series, xi, 36). The mass is pale ash-grey, fine-grained, and on the fracture planes it shows yellowish brown spots of so-called iron-rust; vein-like plates of pyrites of a reddish bronze yellow color pass through the mass; the polished surface shows many particles of metallic iron, the largest

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observed grain was 1½ lines long and one line broad. The mass is crossed by fissures in different directions intersecting at well defined angles, some of them filled up with the material resembling that forming the crust, others by magnetic pyrites and iron. These fissures show the phenomena peculiar to veins, they intersect, join and throw each other out of their course. Although the mass is soft and may be scraped easily, it contains here and there harder globules of a greyish white color, others have a darker grey color, and iron is accumulating in or around them. Some of the inclosed fragments are angular and not round in their intersections, others have a plate-like linear structure and are lustrous. The crust is dull, brownish-black, here and there, with isolated or groups of roundish flat impressions; the surface of the crust has the appearance, as if it was made up of angular plates of an irregular form of 2–3 lines in diameter. It is less than half a line in thickness and contains particles of metallic iron. Haidinger found the sp. gr. at 17° R. =3·526.

It belongs to Reichenbach's whitish meteorites, 2d family, 1st group.

(5.) The stone of *Pegu* was found in 1854, and appears to have fallen but a short time previously. The mass is pale gray a little bluish, made up of round grains or granules, imbedded as it were, in white sand, slightly coherent and almost friable. The grains are both round and angular and from greyish white to dark smoke-grey, the largest not over one line in diameter. Exceedingly small particles of met. iron and pyrites (or pyrrhotine) are pretty regularly disseminated through the mass. Very interesting in the examined specimen is a real vein apparently of pyrrhotine of about half a line in width, a positive proof of its subsequent formation in a large mass.

The crust is greyish black inclining to brown, without lustre and not over ¼ line in thickness. Sp. grav. =3·737. It belongs to Reichenbach's second group.

(6.) The real locality of a stone, which was found in 1846 and which Piddington supposes to be from *Assam*, is not known. Two of the three procured pieces were fragments of the same stone, the other appears to come from a different one as the proportions of nickel and cobalt are not the same. It is beautifully marbled, very solid and compact and admits of a good polish. It resembles the meteorites of Seres, Barbotan, Mezö-Madaras, l'Aigle and others of the 3d family of Reichenbach. The mass is dark grey, irregular rounded fragments of a paler color and nearly half an inch in diameter are imbedded in it, also numerous more or less globular particles, small quite black ones and smaller and larger ones of a bright ash grey color. Inclosed in the pale grey colored portions are brown, also white and yellow metallic fragments. Disseminated in every direction through the paler and darker portions are about equal quantities of metallic iron and pyrrhotine, the distribution of a portion of the iron particles as fringes around the inclosed spherules is very remarkable. It is a proof that during the gradual solidification, after the globules had already been inclosed, the iron particles were yet capable of locomotion.

The crust is dark greyish black and has here and there some lustre. It is very thin and shows some round flat impressions, indicating the back part of the meteorite. Sp. gr. at 17° R. =3·792.

(7.) The fall of the *Segowlee* meteorite took place on March 6th, 1853 at noon. Persons at a distance of a few miles from the place of its fall

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heard a peculiar rumbling noise very dissimilar to thunder, more like the rattling of carriages over a paved street. A man and a boy heard something heavy fall without any other noise and collected some of the stones. Afterwards others were picked up and about 30 were found scattered over an area of about one square mile. All the stones were nearly pyramidal and weighed from ¼ to 4 pounds, one however 14½ pounds. The stone, which Haidinger describes is very unlike any in the Imperial collection, but resembles in color that of Mentz (Mainz). The brown mass is very solid but by no means homogeneous, imbedded in it are numerous round and angular paler and darker particles of more or less hardness, and disseminated through the whole mass fine particles of metallic iron as well as pyrrhotine, more of the latter, the largest grain being two lines long and one broad, the largest grain of the iron ¼ of that size. Many fissures pass through the mass, without any regularity, however. It has a dull appearance, like iron covered with rust, and the whole looks like a poor variety of brown iron ore. A real fresh fracture shows distinct, although slight greasy lustre. The crust is very thin, not over ¼ line in thickness, dark reddish brown mostly dull, only here and there on the flat portions and the rounded edges darker inclining to black and somewhat more lustrous. The whole condition gives the proof of a very slight fusibility. Sp. gr. at 17° R. =3·425. Hardness about 6.

The form of the large stone is very remarkable. Its centre of gravity lies evidently in its thicker part, at the opposite lighter and pointed end are principally the indications of those flat, basin-like depressions. The lower part of the meteorite, as it were the base of it, is remarkably even.

5. *The meteoric iron from Tula, Russia.*—In the year 1846 a mass of iron of over 15 puds (542 pounds avoirdupois) was found 7 versts (4·6 miles) from the station Mariinskoje (in the Government of Tula) on the Moskaw-Tula Road (54° 35′ N. lat. and 37° 34′ E. of Greenw.). It was sold for four roubles (three dollars) to the Myschega iron works in the neighborhood, where the greater portion of it was worked up into axles, wagonsprings, grapnels and other implements, until in 1857 Dr. Auerbach learned of its existence and saved the remainder from destruction. He has given the first notice of it,* and in a preliminary analysis of it found the mass to contain: Iron =93·5, Nickel =2·5, traces of Tin and 0·9 Schreibersite. It yields sulphydric acid, when dissolved in chlorhydric acid, probably owing to the presence of pyrrhotine. Articles manufactured from this iron show after etching a beautifully damasked surface.

At the meeting of the Imperial Academy at Vienna of Nov. 18th, 1860, W. Haidinger has communicated some very interesting observations made on a specimen of this iron obtained from Dr. Auerbach.

The principal mass, although not altogether homogeneous, consists of *iron*, showing indications of Widmannstädtean figures, and imbedded in it pieces of *meteoric stones* with a large proportion of metallic iron disseminated through the same. The angular shape of the pieces and the irregularity of their borders leave not the least doubt as to their nature. They are *real fragments*, separated from larger masses by mechanical force. The uniformity of the fine-grained mixture of the fragments as well as that of the completely metallic nature of the inclosing mass cor-

* Bull. Soc. Imp. de Moscou, 1858, No. 1, page 331.

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roborate this opinion. The spec. grav. of a piece of the fine-grained stone at 12° R. was found to be 4·153; that of the iron as 7·332.

Even before etching, but far more plainly afterwards, three objects can be perceived on the surface of this iron. The greater portion of it is acted upon by the acids, but projecting over it are figures in full lustre, partly angular, partly made up of nearly parallel lines; the length of these ridges is at most four lines, the width of the intervals between two is from one-tenth of one line up to one line, the width of the ridges themselves is hardly one-twentieth of a line. They are evidently Widmannstädtean figures, although they have not the regular arrangement of those of Agram, Elbogen, Lenarto, Toluca, Durango. Similar to those of Bohumilitz the particles of Schreibersite are distributed in ridges along the separating lines of the individuals themselves, they even inclose granular particles made up of very minute individuals. This being the case is shown by the damask-like, although faint lustre of these planes. Besides the fine Schriebersite lines, the etching developes a brownish black lustrous silicate, sprinkled over the metallic surface like fine sands or in little fragments.

The Widmannstädtean figures of the Tula iron show a striking resemblance to those of that of Burlington, Otsego County, N. Y., the latter however is far purer and especially without the fine sandy silicate.

The larger fragments of the enclosed meteoric stone are allied to those containing a large quantity of metallic iron, as for instance to that of Tabor, although the mass is of a dark brownish grey, almost a brownish black color; in the size of the grain it resembles the stones of Charsonville, although the greenish grey color of the latter is far more light.

Judging from analogies observed upon our earth, especially from the appearance of the perfectly angular and not in the least worn off fragments of meteoric stones imbedded in the iron, Haidinger comes to the conclusions that, before the stony masses were inclosed in the iron, they were united as portions of real rocks in *one and the same heavenly body*, from which they came to our earth; and that the metallic *nickeliferous iron formed veins in the granular rock*, which latter was a mixture of metallic iron and a silicate of iron and magnesia before being broken off its connection, an instant which can be considered the starting point, at which the meteorite was set in motion in the cosmical path the conclusion of which is its arrival upon our earth.

The forms of the larger and smaller lumps (cloddy masses?) inclosed in meteorites show, however, many peculiarities, which require a more thorough investigation.

In the meteorite of Hainholz are imbedded globular and ellipsoidal lumps of iron of the size of a hazelnut. They are *no fragments*, and contain, as pointed out by Baron von Reichenbach, who described them, smaller globules or clods of sulphid of iron, the latter trimmed with Schreibersite. It shows these iron lumps not in a very conspicuous manner, they are completely grown together and interlaced with the surrounding silicate. The mass shows after etching a very peculiar appearance, the iron appears in small lumps of about two lines in size of a perfectly homogenous structure, visible by simultaneous reflection, but the interior of these are dendritically marbled by inclosed particles of silicate. Besides,

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there are larger somewhat round particles of the latter and smaller angular ones of one half to one line in diameter, and very remarkable and characteristic pretty large highly crystalline olivines with distinct cleavage. However crystalline the latter may be, they nevertheless have a very irregular surface. Beyond doubt they have been formed as crystals but since their formation have lost their external form.

To consider these iron lumps as well as the olivine crystals and fragments, as Baron von Reichenbach does, as belonging to a previous formation of meteorites or heavenly bodies in a distant space of the universe, is certainly not requisite; in their habitus they have a striking resemblance to the more or less compact formations of basaltic and trachytic tufa, of course not taking into consideration the action of water or carbonate of lime.

Haidinger suggests to consider the structure of a great number of the known meteorites as dry tufas, formed without water, *a meteoric tufa*, an idea which as he remarks may be the starting point of a long series of inferences leading us far away into the field of suppositions of an earlier original formation, but always without losing sight of their immediate connections.

6. *The meteoric iron from Nebraska.*—W. Haidinger gave at the meeting of the Imp. Acad. of Vienna of Dec. 13, 1860, some information regarding the meteoric iron from Nebraska, obtained by Mr. Nathaniel Holmes of St. Louis, Mo.

The original mass weighed 35 pounds and was found on the right shore of the Missouri River in Nebraska Territory, 25 miles west of Fort Pierre, 44° 19′ lat., and 100° 26′ W. of Greenw., whence it was brought in 1857 and presented to the Academy of St. Louis in 1858. It weighed 30½ pounds and the surface was hardly acted upon by rust. According to an analysis by Dr. H. A. Prout, it contains:

Iron,	= 94·288
Nickel,	7·185
Magnesium,	0·650
Calcium,	0·350
Sulphur,	*trace*
	102·473

but not the least trace of cobalt, chrome, manganese or any other constituent. (The Widmannstädtean figures, however, would indicate the presence of phosphid of iron and nickel.)

A segment of the Vienna specimen cut nearly parallel with an octahedral plane showed striæ of half a line in width intersecting at angles of 60° and 120°, with the triangular and rhombic intervals between the inclosing ledges of Schreibersite covering the whole etched surface. They indicate undoubtedly a long continued activity of crystallization during an immeasureable period of time. The Widmannstädtean figures show the closest resemblance to those of the Red River iron preserved in the Yale College Cabinet.

A lithographic plate given in the 4th number of the 1st vol. of the Transactions of the St. Louis Academy represents the whole mass and, on account of the numerous flat depressions, which it shows, evidently from the reverse of that side, which passed foremost through the atmosphere. (See above, Haidinger's views on the typical forms of meteorites.)

F. A. Gth.

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7. ***Abstract of Meteorological Observations, made during the year*** 1860, ***with the averages of eight years, at Sacramento, Cal.***, lat. 38° 31′ 41″, lon. 121° 29′ 44″. Altitude at the top of the levee, in front of the city, 54 feet 5 inches. Height of lower surface of the mercury, 52 feet 5 inches above low tide at San Francisco—with remarks; by THOMAS M. LOGAN, M.D.

1860,	January.	Feb'y.	March.	April.	May.	June.	July.	August.	Sept.	October	Nov.	Dec.	Ann. Mean.	8 Y'rs'g
Barometer.														
Maxima,	In. 30·366	In. 30·599	In. 30·334	In. 30·381	In. 30·280	In. 30·103	In. 30·115	In. 29·967	In. 30·058	In. 30·248	In. 30·357	In. 30·294	In. 30·249	In. 30·236
Minima,	29·797	29·790	29·780	29·728	29·723	29·684	29·650	29·751	29·760	29·753	29·740	29·825	29·722	
Mean,	30·145	30·141	30·047	30·017	30·000	29·886	29·909	29·808	29·911	29·990	30·074	30·030	29·995	30·003
Thermometer.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
Maxima,	56·00	65·00	64·00	77·00	70·00	84·00	90·00	87·00	87·00	78·00	65·00	59·00	73·50	77·54
Minima,	37·00	37·00	39·00	44·00	46·00	58·00	61·00	62·00	57·00	47·00	40·00	33·00	47·17	46·30
Mean,	46·20	49·83	53·80	57·82	58·48	65·64	73·17	73·50	67·59	59·76	53·47	49·84	59·01	59·90
Thermometrograph.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
Maxima,	56·00	66·00	65·00	78·00	74·00	86·00	93·00	92·00	89·00	81·00	67·00	60·00	75·58	78·00
Minima,	32·00	32·00	34·00	38·00	37·00	48·00	51·00	54·00	50·00	41·00	35·00	33·00	40·42	41·58
Range,	24·00	34·00	31·00	40·00	37·00	38·00	42·00	38·00	39·00	40·00	32·00	27·00	35·16	36·42
Force of Vapor.	In. ·405	In. ·376	In. ·439	In. ·519	In. ·488	In. ·547	In. ·637	In. ·651	In. ·591	In. ·559	In. ·410	In. ·428	In. ·503	In. ·521
Maxima,	·178	·097	·173	·206	·191	·305	·356	·397	·293	·225	·140	·132	·228	·205
Minima,	·282	·258	·316	·342	·358	·421	·476	·478	·411	·372	·266	·283	·354	·357
Mean,														
Relative humidity.	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Maxima,	94·00	92·00	93·00	93·00	87·00	89·00	78·00	75·00	77·00	88·00	86·00	88·00	86·17	87·59
Minima,	54·00	28·00	28·00	28·00	41·00	32·00	38·00	38·00	25·00	39·00	28·00	58·00	38·08	32·84
Mean,	82·86	72·10	76·90	71·97	72·65	67·13	64·00	58·89	61·91	72·76	65·34	73·89	70·45	69·92
Number of days clear,	13¼	8¼	8	12¼	11	19¼	23¼	23¼	20	7¼	12	6	165¼	193¼
Number of cloudy days,	17¼	20¼	23	17¼	20	10¾	7¾	7¼	10	23¼	18	25	200¾	171¾
Number of rainy days,	6	8	14	8	10	2	3	0	2	8	2	17	80¾	60¾
Quantity of clouds,	3·5	3·4	4·5	2·8	3·9	1·3	0·7	0·4	0·8	3·7	2·1	5·1	2·7	3·5
Quantity of rain and fog,	2·810	0·931	5·110	2·874	2·491	0·017	0·549	0 000	0 063	0·914	0·181	4·282	19·722	17·372
1st dys & 2d-Force N. wind	12¼ 2·0	11¼ 2·3	9¼ 2·1	7¾ 1·7	8 1·2	11¾ 0·8	14¾ 0·7	2 0·9	2¾ 1·3	10 1·6	15¾ 1·9	9 1·2	86¼ 1·5	52¾ 1·5
" " " N.E. "	2¾ 1·3	1¼ 0·9	2 1·2	1·2	¾ 0·7	0 0·0	¾ 0·8	1 0·4	0 0·3	0 0·0	1 1·0	2 2·0	13¾ 0·8	14 1·1
" " " E. "	2¾ 1·8	2¾ 1·8	1¼ 1·1	0 0·0	¾ 0·7	¾ 0·8	¾ 0·8	0 0·0	1 0·3	¾ 0·5	2 1·3	2 1·2	11¾ 0·7	12¾ 1·1
" " " S.E. "	5¾ 1·7	2¾ 1·1	5¾ 2·0	3¾ 2·6	1¾ 1·3	1 0·8	4¾ 1·4	4 1·1	3¾ 2·1	5 1·5	6¾ 2·6	4¾ 2·1	9·6 1·6	7·3 1·8
" " " S. "	3¾ 2·1	3¾ 2·1	6¾ 2·5	5 2·8	3¾ 2·1	1·5	4¾ 2·1	1·9	2·3	6¾ 1·7	3¾ 2·0	8¾ 2·1	9·5 2·0	6·7 2·1
" " " S.W. "	2 1·4	1¾ 1·7	4¼ 2·4	5 2·2	5 2·6	6¾ 2·6	6¾ 1·7	6¼ 1·9	5 1·2	4¾ 1·7	1 1·3	1 2·0	4·4 1·8	5·4 1·9
" " " W. "	1¾ 1·1	3 1·8	2 1·9	3 1·8	5 1·6	6¾ 1·9	4 0·9	3¾ 0·9	3 0·9	2¾ 1·1	1¾ 1·0	2 2·4	8·8 1·5	10·1 1·2
" " " N.W. "	3¾ 2·1	1¾ 2·3	3¾ 1·4	1¾ 0·6	¾ 0·4	1¾ 0·6	¾ 0·7	1¾ 0·4	5¾ 1·4	3 1·7	2¾ 2·0	¾ 2·0	26 1·5	7·1 1·6

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Disturbances of the electrical equilibrium are rarely manifested in California, and but four times have lightning and thunder been witnessed in the whole year, 1860, viz: on May 3d, July 11th, September 26th and October 17th. During the storm of September 26th, which was accompanied with a sprinkle of hail, the lightning was very vivid, preventing for the first time since they have been set up, the working of the telegraph wires. Hail and snow are also seldom experienced. Besides the instance of hail just mentioned, we were visited with a sprinkle of both hail and snow on the 3d of May.

The Aurora Borealis, which has been seen here only eleven times in the same number of years, has been witnessed on no less than four different occasions during the last year. The first and most remarkable was that on the 4th of July, and although the brilliancy was not so great, nor the field of observation so extended as that on the 28th of August of the preceding year, still it was seen at places wide apart, and at each point of observation presented the same distinctive features. This is at least the second instance on record in which this phenomena has been observed cotemporaneously in California and the Eastern States.

Earthquakes have not been as frequent during the year at San Francisco as usual, and the only one recorded, in our Register here, was not felt in the former place, nor at any other point among the Coast Range mountains. This, at Sacramento, was experienced on the 15th of March, at ten minutes past 11 h. A. M., during a stagnant and cloudy condition of the atmosphere. The direction of the impulse seemed to be from northeast to southwest—as it was sensibly experienced at various places between here and Carson City. At the latter place (4,741 feet above the sea), the intensity of the force was considerably greater than at Sacramento, where it was only sufficient to cause a slight vibratory motion among chandeliers and other pendant objects.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *National Observatory.*—The accession of Lt. JAMES M. GILLISS to the direction of the Washington Observatory is a fact of happy omen for science. It may perhaps seem to some but a tardy act of justice that the man who was chiefly instrumental in securing the establishment of this Observatory should at last be placed at its head. But whatever there is to regret in the past, (and alas how much there is!) in the administration of this Institution, it is a matter of general congratulation in scientific circles that the distinguished chief of the Chilian Astronomical Expedition should now adorn the post lately so ignominiously left vacant.

2. *Earthquake at Mendoza.*—On the 20th of March last, about 8½ o'clock in the evening, a most destructive earthquake overwhelmed the city of Mendoza in the Argentine Republic, South America. Mendoza is in lat. 32° 53′ S., lon. 69° 6′ W., and is about 2900 feet above the sea on the eastern slope of the Andes. The shock is said to have come from the N., followed by another from the S., and to have lasted only about five seconds, in which brief time nearly the whole town was utterly laid waste and from 8000 to 12,000 lives were destroyed. The shock was not felt at Valparaiso, distant about 150 miles in a right line W. by S.

3. *Prussian Expedition to Japan and China.*—A letter from Baron Richthofen, Geologist to the Expedition, from Yeddo, dated 25th of December, 1860, states that they were about leaving Japan, to go to Shang-

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hai and then to the Phillipines, Siam and Java. The expedition thence returns to Europe by sea while Baron Richthofen proposes to cross the Asiatic continent.

4. *Correction.*—A letter from Prof. James Hall, in regard to trilobites from the Wisconsin 'Potsdam,' says: "The specimen you send me is from *Trempeleau* and not Black River Falls, as I had anticipated—having made a journey of thirty miles over bad country to "Black River Falls" to find the rocks there of *Sienite* with a little coarse grey sandstone a mile below." "The Lingula accompanying the trilobites is *L. polita*, (see Geol. Rep. Wisconsin, 1860.)" I believe the original authority for the locality was Prof. Daniels. F. H. Bradley.

Book Notices.—

1. *Ancient Works in Western New York.*—In the 13th Annual Report of the Regents of the University of the State of New York we find, among other matters interesting to science, an important document on the remains of early human art in the region contiguous to Lake Erie, and comprising the counties of Chautauque and Cattaraugus—by T. Apoleon Cheney, *Civil Engineer*, &c., 1859.

In a cursory perusal of this report and after an inspection of its illustrations, we are convinced that the dominion of that very ancient and unknown people, by whom the earth works of North America were raised, extended to Lake Erie and was a part of the great system of similar works which occupied the territory of several of the Western and Southwestern States, to a great extent, also, the valleys of the Ohio and Mississippi and their confluents extending quite to Mexico. There is so great a similarity, not to say identity, of structure, position, arrangement and contents whether of human remains, or of artistic works, when art was young, or of collections of minerals and other objects of nature and art that our curiosity is excited still more to obtain a solution of the question, 'who were the people who erected these remarkable works, forts, lines of defense, mounds of observation, or barrows of sepulture?' Our modern Indians have no such skill—nor have we reason to believe that any such structures as are named above were ever erected by them or their ancestors and this appears to be the opinion of Mr. Cheney.

His labors have been praiseworthy—himself an amateur archeologist, he works, we believe, without pecuniary reward, deriving no substantial aid from his investigations, and if we are not misinformed, under the pressure of ill health and with a family entirely dependent upon his exertions in other branches of research and literature—and who have at times suffered in an extreme degree.

We sincerely wish him every aid to which he is so well entitled—especially to enable him to bring a successful result extensive investigations in which he is now engaged as to the origin and history of the builders of the mounds and fortresses which are the only record of that wonderful extinct people.—B. S.

2. *An Elementary Treatise on Human Anatomy;* by Joseph Leidy, M.D., with 392 illustrations. Philadelphia: Lippencott & Co. 1861. 8vo, pp. 663.—This original and truly admirable treatise on Human Anatomy bears everywhere the signs of its author's genius. Concise and clear without formality, learned without pedantry, it is a model of what every text book in a descriptive science should be. The illustrations are excellent and mostly from original drawings of the author or his friend

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Dr. Schmidt, put on wood by the masterly hand of August Wilhelm, a young artist of Philadelphia. Every mechanical detail of paper and typography has received scrupulous care.

3. *Handbuch der metallurgischen Hüttenkunde;* von BRUNO KERL, 2te, *umgearbeitete und vervollständigte Auflage.* 1er *Band*, 1te *Abtheilung*, Freiberg, 1861.—This first instalment of a second edition of Prof. Kerl's excellent and exhaustive treatise upon metallurgy, revised and brought up to the present date, will be welcome to every one who takes interest either in the theory or practice of smelting.

To those familiar with the previous edition of this work we need not urge its encyclopædic character or its importance to practical men. Certain it is that no other handbook upon the subject can be mentioned in comparison with it. In breadth of scope, amplitude and completeness of detail, and honesty of purpose, the work is on a par with any of the standard treatises upon other branches which do so much credit to the scientific literature of Germany. Though comparatively little has been heard heretofore of the scientific merits of this work, it nevertheless contains in reality,—incidentally as it were,—almost everything which is known of the chemistry of the metals, while the scrupulous care with which references to original memoirs, etc., are given, and the abundance of these citations renders it an invaluable aid to the student and investigator. The book is copiously illustrated and well printed upon excellent paper in the best style of the house of Engelhardt (THIERBACH.) Westermann & Co., of New York have it in store. F. H. S.

OBITUARY.—

DR. CHARLES ROBB, Professor of Natural Science at the University of New Brunswick, died at Fredericton, April 2, aged 46. He received his medical degree at the University of Edinburgh, and having subsequently studied at Paris entered on the duties of his professorship in 1827, which he filled for twenty-four years with zeal, fidelity and ability. Although residing at such a distance from any scientific centre and without the means or opportunities for original research he was nevertheless known to his associates and friends as an accurate observer and deep thinker. He made a careful study of the geology and mineral resources of New Brunswick and the museum of his College which he collected and arranged, remains the result of his labors. In all matters connected with the advancement and prosperity of the Province he took a deep interest. He was for many years Secretary to the Provincial Board of Agriculture and he will long be remembered as one of the pioneers of science in New Brunswick.

HERMANN DAUBER, the successor of the lamented *Grailich*, as adjunct-curator of the Imperial Austrian Mineral Cabinet, died at Vienna, March 12th, in the 38th year of his age. Dauber's well known contributions to Crystallography, during the past fifteen years, have placed him in the front rank as a crystallographer and will cause his name long to be remembered as one of the most accurate and conscientious observers in this department of science.

BOOKS RECEIVED.—

DR SCHLAGINTWEIT'S India and High Asia. Text. Vol. I, Astronomical and Magnetic Observations. 4to, pp. 494. Leipzig: F. A. Brockhaus.

Recherches Expérimentals sur l'Élasticité des Méteaux faites à l'Observatoire physique centrale de Russie par A. T. KUPFFER (Directeur, &c.). Tome I (avec 9 planches). St.-Pétersbourg. 1860. 4to, pp. 430.

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[*Continued in next Number.*]

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XVI.—*Waterglass;* by J. M. ORDWAY.

PART I.—HISTORY AND MANUFACTURE.

THE soluble alkaline silicates have of late years come into extensive use in the arts, and seem likely to constitute a large and permanent branch of chemical manufactures. The common works on technology do not treat of them as fully as their present importance demands, nor can all that could be desired be found within the limits of any single paper hitherto published on the subject.* It is here proposed therefore to collect details from various scattered memoirs, as well as from private experience, and present a concise but more complete account of the history, manufacture, nature, and uses of the soluble silicates of potash and soda.

The later alchemists were acquainted with the deliquescent tersilicate of potash,—$\dot{K}_2\tilde{S}i$,—the basis of *liquor silicum*. Thus Glauber, in giving his second method of testing sand for gold, says:—"Take one part of white quartz or sand, mix it with three or four parts of salt of tartar, or any other alkali, and put the mixture into a crucible, but so as not to fill more than one-third of it; since otherwise, in melting, the mixture would rise and flow out of the crucible. Let it stand [in the fire] half an hour that it may be well ignited and changed to a pellucid glass.

* A pretty full resumé of all that had been published on Waterglass up to 1857, is given by E. Kopp in the Moniteur Scientifique, tome i, livraison 4me.

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Pour it out and dissolve in water, or better, in lye; and the sand or silex will be dissolved and changed into a thick water."*

In 1825 there appeared a memoir in German "On a New and Useful Product Obtained from Silex and Potash, by Dr. Johann Nepomuk von Fuchs," in which we find the following account of the first discovery of soluble glass, or, as Fuchs provisionally named it, *waterglass*:—"I obtained it first about seven years ago, in pouring concentrated potash lye on very finely divided silica which had been precipitated from *liquor silicum* with sal-ammoniac, and well dried. The potash was absorbed by the silica with a sensible elevation of temperature, and the whole soon changed into a very firm, transparent, glass-like mass which proved to be permanent in the air. It did not occur to me that the same thing might also be produced by dissolving silica in potash and evaporating the fluid; since I then, and for a long time afterwards, held with all chemists the erroneous notion that a combination of silica and potash, to be permanent in the air, must be insoluble in water, and that a soluble product must necessarily be deliquescent. Two years afterwards, when I wished one day, for analytical purposes,—for which I first brought silicate of potash into use,—to prepare some as fully saturated with silica as possible, I learned to procure the substance under consideration, by the method of solution. For this purpose I took freshly precipitated silica, poured on it as much potash lye as I judged to be necessary for its solution, and brought it to a boil. The silica very soon disappeared, and, in order to saturate fully the alkali present, to my no slight astonishment, I was obliged to add a quantity of silica still greater than I had taken at first. After this was done the solution was boiled a long time to concentrate it, and thus came to the consistency of syrup; and on the surface there appeared a tough pellicle which dried in the air to a transparent glass. All bodies which came in contact with this fluid received a glassy covering that attracted no moisture from the air but became much the harder and more brittle. From this I saw that the product before me was the same which had been obtained before by the process of absorption."

The author goes on to say that the burning down of the theatre at Munich contributed to the completion of his discovery. For when the new building was to be erected, diligent inquiry was made for something to protect wood against fire; and many substances having been tested and rejected, it occurred to him

* Novum Lumen Chymicum, Amstelodami, 1664. A somewhat earlier mention of the same substance is made by Van Helmont. J. F. Gmelin quotes the following passage from his 'De Lithiasi,' published in 1644:—"Porro lapides, gemmae, arenae, marmora, silices, &c., adjuncto alcali vitrificantur: sin autem plure alcali coquantur, resolvuntur in humido quidem: at resoluta, facili negotio acidorum spirituum, separantur ab alcali, pondere pristini pulveris lapidum."

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to make trial of the waterglass. Therefore with Dr. Pettenkofer as an associate, he made many experiments which showed its entire efficiency as a protective agent, and it soon assumed a greater importance than he had at first attached to it. They then labored to find some cheap and easy mode of preparation, which might render waterglass available for economical uses. In the first place they made *liquor silicum*, and dissolved in one portion the well washed silica precipitated from another portion. This method was too costly, and the product was not all that could be desired, since it contained too much carbonate of potash. Finally by trying the direct fusion of various mixtures of potash, sand, and charcoal, they got a product which, when powdered, dissolved slowly but almost completely in boiling water, affording a solution free from carbonic acid and perfectly saturated with silica.

In making the article for actual use they took for each charge 30 lbs. of well purified potash, 45 lbs. of quartz sand, and 3 lbs. of powdered wood charcoal. This was melted in a refractory crucible, and at the end of five or six hours, when the well fused mass had subsided into a quiet state, they dipped it out with an iron ladle and threw in a fresh charge.

Fuchs found in one sample of the dissolved silicate proportions corresponding to $\dot{K}_2\dot{S}i_5$. In another analysis he obtained somewhat more silica and less alkali.

They also made a silicate of soda with such relative quantities of materials as should give $\dot{N}a_2\dot{S}i_3$; but in Fuch's last work, published since the author's death, he recommends 45 lbs. of quartz, 23 lbs. of dry carbonate of soda, and 3 lbs. of charcoal, which would make $\dot{N}a_2\dot{S}i_5$. Perhaps the recommendation was given on theoretical grounds, for such a product is altogether too hard of solution for practical use. In fact Fuchs, for most of his experiments, took potash waterglass, and the potash silicates are more soluble than the corresponding soda compounds.

Since 1825, owing to the enormous extension of the soda manufacture, the potash and soda salts have exchanged places as far as commercial value is concerned; and now no one thinks of using the potash salts except for those cases in which they are peculiarly suitable. Silicate of soda therefore is the article more commonly employed at the present time, and as found in commerce it varies from $\dot{N}a\dot{S}i_2$ to $\dot{N}a_2\dot{S}i_4$.

For designating the substances under consideration the Anglicized German name 'waterglass' is very convenient as a generic term applicable to either the potash or the soda glass, to the solid or the liquid product. It suits the genius of our language and should be generally adopted in preference to the less concise and less accommodating expression 'soluble glass.' It is true, an unpleasant recurrence of sounds may be got rid of by calling

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ible glass' 'liquid glass,' but we thus introduce
ich is no less objectionable because it can be
cle only in a single state. The word 'water-
nsive enough to express every variety and
nce discovered by Fuchs, while it properly
d alkali or 'liquor silicum,' the "kieselfeuchtig-
keit" and "kieselsaft" of the Germans. Yet the two things are confounded by many. Thus while writing this, I have before me the printed directions given by an English manufacturer for dissolving his "soluble glass to produce liquor silicis;" and of two specimens of his glass, one proves to be a sesquisilicate of soda, and the other a bisilicate.

Still though the extremes are unlike enough, there can be only an arbitrary line of distinction drawn on the middle ground. Anything more alkaline than Na_2Si is prone to deliquescence, and is too poor in silica for most uses, and it would perhaps be but just to consider 'waterglass' as including nothing more basic than the sesquisilicates. Again with regard to this last term it may be remarked that as silica in combining with the alkalies is regardless of precise atomic ratios, 'silicate' without a limiting prefix, conveys no more definite idea than 'hydrate;' and the world being still divided respecting the atomic constitution of silicic acid, a limiting prefix has to be itself interpreted, unless the context makes its meaning apparent. In this paper silica is taken as SiO_3, merely because custom has made this the more familiar formula.

The fact that silicate of soda is not, like alum or rock salt, an article of definite and invariable composition, is not generally appreciated by consumers, who often absurdly judge of the goodness of a sample by the greater or less time required for dissolving it, and by the hydrometer strength of a solution made from a given weight. A just estimation would take into account the quantity of insoluble matter, the amount of saline contamination, and the relative proportions of soda and combined silica. A dry silicate may have mixed with it no inconsiderable percentage of carbonate, sulphate, sulphid, and chlorid, which greatly impair its quality, though they help to raise the hydrometer. And then again the greater the proportion of alkali, the more quickly may the solution be effected. But for any use to which the article is applied at present, it ought not to contain more than two equivalents of soda or potash to three equivalents of silica, and therefore should properly be rather hard to dissolve.

Manufacture.—It was discovered some years ago that flint or quartz enters into solution when boiled with caustic alkalies under strong pressure; and this method has sometimes been resorted to for manufacturing the silicates of potash and soda.

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Thus to obtain a liquid for making 'Ransome's artificial stone,' the direction is given to prepare, in the first place, a perfectly caustic lye with soda ash and lime, and subsequently add enough caustic baryta to decompose the sulphate of soda present. The clear liquor is then to be heated some thirty-six hours to about 300° F., in an iron boiler containing a wire cage filled with broken flints.* The solution is afterwards concentrated by evaporation in open pans. A sample of the substance thus produced is said to have contained 47 per cent of Na_2Si.† This would be a *liquor silicum*, and altogether too alkaline for most uses.

A very rational improvement of the process is to use infusorial silica or those minerals consisting of silica in its active modification, instead of inert quartz. Bergeat proposes also the fine residue left in the manufacture of sulphate of alumina from porcelain clay.‡

I have not met with any published statement showing the maximum amount of silica which may practically be brought into combination in this way. But even supposing that the alkali could be fully saturated, there are still strong objections to this high pressure system. In fact a more tedious and costly way could hardly be devised, unless we go back to Fuchs' original plan of dissolving precipitated silica in potash lye.

By operating in the dry way, the work may be better done, in less time, and with less expensive materials, less trouble, and less costly apparatus. The easiest method is to fuse sand with carbonate of potash or soda. The cheapest way yet devised,—and the one therefore which seems likely to supersede all others eventually,—is to decompose a sulphate with quartz sand and carbon. It has indeed been suggested that silicate of soda might be made directly from chlorid of sodium, with the aid of overheated steam. It is very doubtful, however, whether any apparatus could be got up, capable of resisting at the same time the very great heat required and the action of the vaporized chlorid of sodium, of the gases passing off, and of the intensely heated silicate remaining. Otherwise such a process might be carried out by passing the mixed vapors of water and salt through an excess of strongly ignited sand,§ provided the product were quite infusible at the temperature of decomposition. But when a substance fluxes, and especially when, like glass, it melts to a tough mass, or at least agglutinates, the action of vapors or gases on it can be only superficial and therefore must be exceedingly slow. In the roasting of ores, for instance, the metallurgist has

* A figure of the apparatus used is given in Ure's Dictionary of Arts, Manufactures, and Mines,—latest Am. Ed.—Art. 'Stone, Artificial.'

† Knapp's Technology,—Am. Ed.,—ii, 398.

‡ Wagner's Jahresberichte über die Fortschritte der Chemischen Technologie,—iv, 205.

§ See this Journal [2], vi, p. 260–266.

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to exercise the greatest care to keep the matter under treatment in a porous condition, or else many of the metallic sulphids would volatilize sooner than oxydize. And there seems to be no good reason why the same principle should not hold true in oxydizing by steam as in oxydizing by air. The application of Tilghman's process to the manufacture of silicates from simple alkaline chlorids,—however beautiful the method may be in theory,—does not then *a priori* promise advantageous results. The product would at best be too siliceous, and to make it soluble by remelting with carbonate of soda, as proposed by E. Kopp, would add too much to the cost.

Waterglass has sometimes been prepared, as by Fuchs and Pettenkofer, in large crucibles or in the common pots of a glass furnace; and when but little is wanted or a very pure product is desired, this may be the better way. But as the consumption is now very large, and absolute purity is seldom required, most manufacturers use reverberatory furnaces. For fuel I have known anthracite to be burned, though bituminous coal is far better and more economical. Some make an intricate mixture of sand and soda ash by grinding or sifting them together, and heap it up on the bed of the furnace till there is only room enough between the charge and the arch for the products of combustion to pass along,—a little vacant space being reserved just within the charging door. The mixture continually fuses on the surface and runs down to this vacant space, and the fluxed product is drawn out, a little at a time, as it collects. When the whole charge is thus disposed of, a fresh one is thrown in. This method is indeed rude and unsatisfactory, and imposes inconvenient restrictions. Yet under the care of a judicious workman, when the materials are of the best quality and the fire burns well, the result is much better than might be expected. Commonly, however, the silicate so made is exceedingly variable, that of no two drawings being exactly alike. It varies in color from almost white, through every shade of brown, to black. It contains more or less unchanged sand and undecomposed carbonate of soda as well as sulphid and chlorid of sodium and sulphate of soda. In specimens of the article so prepared and intended to be alike, I have found the quantity of dry soda to vary from 24 to 33 per cent, while the uncombined sand sometimes amounted to ten per cent. In this mode of working the consumption of fuel is comparatively small, and the wear of the furnace is slight, but, on the other hand, the thorough mixing of the materials requires no little labor, and the product is rather fritted than completely vitrified.

A better plan is to throw into the furnace but a moderate quantity of the rudely mixed ingredients, keep the whole charge in till it is seen to be well done, and then draw it all at once.

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Thus the mass is completely under the control of the workman, perfect decomposition may be insured, and the product can be made uniform in color and quality. In the strong heat, the chlorid of sodium is mostly volatilized, and much of the sulphate is decomposed and changed to silicate. But there usually remains enough sulphid of sodium to communicate a brown tinge. The hotter the furnace is, the easier is it to get a light colored article. The brown color may be completely removed by throwing in a few pounds of arseniate of soda,—or a mixture of arsenic, soda ash, and nitrate of soda,—and stirring it well in just before drawing the charge. Antimoniate or stannate of soda would answer as good a purpose and would be safer to handle. Still I have never known any injury to health to result from using the arseniate.

With a furnace whose bed had an area of 24 square feet, the grate being 3 ft. by 2 ft., and consuming about 83 lbs. of Pictou coal per hour, I have worked four charges in 24 hours, each consisting of 250 lbs. of soda ash,—80 per cent,—and 315 lbs. of pure quartzose sand. The well fused mass was decolorized with about 4 lbs. of arseniate of soda, and then drawn out into a kettle full of cold water kept constantly renewed. As foreign salts can only be mechanically mingled with the melted glass, any particles of sulphate of soda that have escaped decomposition, are dissolved and washed away as the fluid mass breaks up into minute fragments by contact with water. The glass so obtained had a very slight greenish color and was quite pure.

To make a more readily soluble sesquisilicate for calico printers, the charges consisted of 260 lbs. of soda ash and 250 lbs. of sand.

Fuchs directs an addition of coal dust to be made to the materials, but when the heat is strong, such an addition is entirely unnecessary. The drawing into cold water causes but little loss when we have bisilicate of soda to deal with, though with anything more alkaline than sesquisilicate of soda or bisilicate of potash, the waste is too considerable. When waterglass is to be dissolved at the manufactory, it may as well be drawn into water, for this saves the expense of grinding. But when it is to be sold in the solid form, water drawing cannot be recommended; since after the silicate has once been wet, it is almost impossible to get it dry again, and if it is packed in casks, the particles soon cohere into one solid, unmanageable lump. To avoid such a difficulty the melted mass may be received into a thick cast iron pan or half cylinder, and, when cold, broken up and ground in suitable mills. The best apparatus for grinding would be a large edge-stone mill. A series of toothed crushing rollers made of chilled cast iron answers very well. Common Buhr mill stones wear away too fast.

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When drawing into water is deemed advisable, the workman should always make sure that the finished charge in the furnace contains no foreign saline matter visible as a limpid liquid amidst the viscous glass; for this thin liquor will produce violent explosions as it touches the water, though the silicate itself behaves very quietly.

The use of Glauber's salt instead of carbonate of soda in making window glass,—a substitution which was successfully carried out by Baader in 1808,—naturally suggests the employment of the alkaline sulphates for preparing waterglass. By some experiments made thirteen years ago with reference to this matter, I found that two equivalents of simple sulphate of soda required not less than three equivalents of sand for the complete expulsion of the sulphuric acid; and further trials made in the large way have gone to confirm this result. The decomposition of sulphate of soda is much less difficult when lime, alumina, or another sulphate is present. Thus one equivalent of sulphate of baryta, one eq. of sulphate of soda, two eqs. of carbon, and two eqs. of silica, melted easily to a perfect glass.—One eq. of sulphate of baryta, one eq. of sulphate of soda, two eqs. of coal, and three eqs. of sand, required a stronger heat.—One eq. of sulphate of baryta, two eqs. of sulphate of soda, three eqs. of carbon, and three eqs. of silica, fused easily to a clear glass.—One eq. of carbonate of lime, one eq. of sulphate of soda, one eq. of coal, and two eq. of silica were also vitrified with little difficulty. Feldspar,—$\dot{A}l\,\ddot{K}\,\ddot{S}i_4$,—with the aid of carbon, decomposes nearly three eqs. of sulphate of soda, giving a very 'short' product which when powdered is readily attacked by acids, and might be used in the manufacture of alum.

The vitrification of sulphate of soda or potash, requires more heat, more time, and more skill than the production of waterglass from the carbonates; yet the far greater cheapness of the sulphates renders their use more economical. It is better to take purified sulphate of soda made by dissolving the crude article, precipitating the iron with lime, and evaporating the clear solution to dryness. This however involves time, labor, space, and extensive apparatus; while a silicate pure enough for ordinary use may be prepared directly from the clean residue of the nitric and muriatic acid manufacture. The iron, lime, and magnesia contained in the crude sulphate, do indeed somewhat impair the solubility of the product, yet when it is a sesquisilicate, it can be dissolved by hard boiling. If a little soda-ash is added to the charge in the furnace, after the decomposition of the sulphate is finished, the subsequent solution is considerably facilitated.

The heat required is nearly or quite as great as that of an iron puddling furnace; and the melted materials act severely on

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the interior of the furnace,—especially on the side walls just at the surface of the fused charge. A large allowance must therefore be made for 'wear and tear.' The furnace should be substantially built, the interior being constructed of very tough and compact fire bricks rich in alumina; and it would no doubt be advantageous to line the flue and the sides of the bed with some hard pressed and well burned blocks of the same material as glass pots. As economy of time and fuel requires a rapid consumption of coal, the grate surface must be large, say equal to one-fourth of the area of the bed, and the throat over the bridge should not be too contracted. To avoid the vexation of a leaking fire bridge, it is best to have the working bridge about four inches lower than the level of the grate. The sills of the charging and discharging doors may be on the same plane as the grate, and a gentle slope should connect the sill of the discharging door with the general level of the bed.* Were the doors not thus raised, the melted sulphate of the intumescent glass would flow out unbidden. I have used a furnace with a working sole 40 square feet in area, and a grate surface of 11 square feet. The chimney is about 50 feet high, and the arched flue leading straight into it, is 9 inches high in the centre, and 20 inches wide. In such a furnace four charges are worked in 24 hours, with a consumption of about 5000 lbs. of Pictou coal,—each charge consisting of 550 lbs. of white sand, 600 to 700 lbs. of crude sulphate of soda, and 70 to 90 lbs. of anthracite coal dust.† The approximate amount of carbon is best determined by actual trial. But on account of varying accidental influences no two charges are found to require precisely the same weight of coal. It is therefore best to reserve a few pounds to be thrown in afterwards, or not, according to circumstances. When the charge is well fused and the sand has all disappeared, if there is an excess of coal, the glass will remain black. If there is a deficiency of carbon, the mass will gradually become light colored,—as is shown by samples taken out from time to time on the end of an iron rod,—and on stirring, the sulphate will be seen to separate, as a thin liquid, from the pasty silicate. The workman should then throw in a pound or two of coal and stir well. The mass is now suddenly puffed up with the escaping sulphurous acid, but soon subsides again. A second or third addition of coal may be necessary, and some practice and tact

* The plan of having the bed lower than the grate may be highly recommended when there is a material to deal with, that becomes fluid in a strong heat. Thus I have found it to be very advantageous in smelting artificial sulphate of lead with iron borings and coal. A low sole necessitates a high arch, but when the arch slopes regularly downward from the highest point over the bridge to a low and wide flue, the consumption of fuel is found to be no greater than in a furnace of the more common form.

† When soda ash is used instead of the sulphate the same furnace affords six somewhat larger charges in 24 hours.

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are required on the part of the workman that he may stop at just the right point. An excess of sulphate can be remedied, but an excess of coal is hard to get rid of. When the melted mass has become smooth and homogeneous and light colored, it may be decolorized with arseniate of soda and drawn out, the hoes being changed as they get hot and pliant.

For making a liquid or pasty silicate, the glass coarsely ground may be boiled with water till the solution stands at about 25° B. after cooling. If it is made much stronger it will not settle readily. Some dissolve waterglass by blowing steam directly into the water, but in that case the solution goes on very slowly, because the heat is insufficient. It is far better to have an iron kettle heated by a fire. After being allowed to deposit the insoluble matter, the liquid may be concentrated by evaporation to any required degree within certain limits. When it becomes thick, the further application of heat is attended with no little difficulty; for the silicate then rapidly adheres to the kettle, and there is needed very diligent scraping with a chisel-pointed bar to keep the bottom and sides of the vessel clear of the spongy coating. And to push the evaporation to dryness, is quite out of the question. Sesquisilicate of soda cannot conveniently be made stronger than 50° B.

When we wish to obtain the greatest possible relative amount of silica in solution, it is necessary to make the glass of none but the purest materials. Earthy or metallic oxyds very much lessen the solubility of the product, and if more than a mere trace of them is present, a larger proportion of alkali is required to render the mass capable of yielding readily to boiling water. A silicate so contaminated will not in fact enter directly into solution; it is only decomposed by boiling with water, into a more alkaline silicate which dissolves and a compound earthy silicate which remains as a bulky residue, often in the form of plates or scales. Thus of a well worked waterglass made from crude sulphate of soda, water took up only 89 per cent, leaving a copious sediment consisting of soda, lime, magnesia, alumina, ferrous and ferric oxyds, and silica. Indeed common glass is but an alkaline silicate rendered insoluble by a more considerable amount of lime or oxyd of lead. Fuchs himself pointed out the necessity of having the sand free from lime and alumina. He states that a little iron does no harm; but this can be true only when the glass is left brown or black so that the iron exists in the state of sulphid. Fuchs says that with pure quartz and pure potash an insoluble glass cannot be prepared. "For if we take two parts of quartz to one of potash, we obtain,—as I have convinced myself,—a glass which partly dissolves in water." This would make about $\dot{K}, \tilde{S}i_{1,6}$. "Besides even glass containing lime is more or less attacked by boiling

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water, as has been long known, and as Scheele especially proved. I found that many a glass, when it is rubbed a long time with water in an agate mortar, reacts very sensibly alkaline, and that when finely powdered glass is boiled for many hours with water, a fluid is obtained which has an alkaline reaction and gives a flocculent precipitate with sal ammoniac." Pelouze found that when good white glass,—$\dot{N}a_8\ \dot{C}a_{11}\ \ddot{S}i_{32}$,—was finely pulverized and boiled for some time with water, about three per cent was dissolved. Another kind, containing a less proportion of lime, ($\dot{N}a_4\ \dot{C}a_2\ \ddot{S}i_{13}$,) yielded to boiling water 18·2 per cent, and what entered into solution proved to be sesquisilicate of soda.* And Fresenius affirms that even a glass vessel yields a ponderable amount of its substance to water which is boiled in it only a short time. Still a simple potash or soda silicate with three equivalents or more of acid to one of base, may be considered as practically insoluble. Thus Peligot found the so-called 'alabaster glass' to consist almost entirely of silica and potash in such proportions as to make $\dot{K}\ \ddot{S}i_5$, were the silica all in combination. But in this case a part of the silica is merely diffused, and so produces the opacity of the glass. Stein however found besides, 1·5 per cent of lime and 2·3 per cent of bone earth, in alabaster glass.†

Analysis.—When a silicate is in lumps or coarse powder, we can judge as to the absence of foreign salts by the degree of transparency. A well made article is clear, bright and homogeneous. One not properly prepared has a dull, resinous appearance; and if there is much sulphid or chlorid present, the mass will be spotted, streaked, cloudy, or entirely opaque. Less than ten per cent of intermixed saline matter, is sufficient to render waterglass quite milky.

But the real value of any sample can be ascertained only by a chemical examination, and as the analysis is liable to some peculiar chances of error, it may be well to point out a few of the peculiar precautions to be observed.

In the case of a dry glass, especial pains must be taken to insure the solution of everything that water will take up,—a matter requiring some labor and time. For determining the amount of alkali, I take an average of the specimen to be tried and patiently rub some, in a very hard, four inch Wedgewood mortar, to an exceedingly fine powder,—grinding only about a gram at a time, and being careful to keep it as dry as possible. Five grams or more are then weighed out and boiled with forty or fifty times as much water, in a porcelain dish, for a time, varying from fifteen to ninety minutes, as occasion may require. To prevent a violent bumping, the mixture must be stirred

* Liebig and Kopp's Jahresbericht for 1856, p. 354.

† Wagner's Jahresbericht,—iv, p. 244.

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briskly and without intermission, during the whole time of heating. If there is no uncombined sand in the article under treatment, the cessation of the gritty feeling, shows plainly when a farther application of heat is unnecessary. For a well fluxed sesquisilicate of soda, 15 minutes boiling is quite sufficient. Any uncombined sand present in a sample, causes an uncertainty in the time required. Should there be a gritty residue after half an hour's boiling, it is advisable to stop and make a preliminary testing. If we find less than 28 per cent of alkali indicated, it is best to start anew and heat at least an hour and a half.

After the solution is completed, the whole should be made up to a given weight,—being at least forty times that of the dry silicate,—covered, and allowed to get perfectly cold. The larger part of the liquor being then poured off, without disturbing the sediment, a suitable proportion of the whole amount may be weighed out and tested by any of the common alkalimetric methods. Filtration is tedious and unnecessary, for though the decanted liquid is seldom perfectly clear, even after long repose, the quantity of suspended earthy matter is altogether too insignificant to influence the correctness of the result. Waterglass which is already in the liquid or pasty state, must be largely diluted before trial, since a strong or a warm solution is apt to gelatinize before all the acid is added, and then exactness is impossible, because the thick jelly is not readily penetrated by the acid subsequently dropped in. Therefore should gelatinization occur, a new trial must be made with a weaker or colder solution.

When the operation is finished, if sulphuric acid has been used, the tested liquid itself can be dried down, and then the silica is left in a coarse granular form, easy to wash, collect, ignite and weigh. If the precipitation of the silica is effected with an ammonia salt, the residue is likely to be very bulky, and so fine and light that it requires no little care to keep it from blowing partly away during ignition.

An excess of nitric or chlorhydric acid added to very dilute waterglass, causes no apparent change for a long time, and in a weak solution so treated we may test for sulphates or chlorids, for iron or for arsenic acid, without previously removing the silica. For the quantitative determination of sulphate and chlorid it is best to treat the silicate solution with an excess of nitrate of ammonia instead of an acid, and thus prevent any loss of chlorine in drying down.

If sulphids are present in a liquid waterglass, a small bit of sulphate or carbonate of lead dropped in will soon become discolored.

When the per-centage of water is to be ascertained, it is not well to heat the solution by itself, for in such a case it finally expands to an enormously bulky, vesicular, unmanageable mass.

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A known quantity of freshly ignited sulphate of lime should first be stirred in, the weight of the sulphate being at least twice as great as that of the dry alkali supposed to be present. Then in a few moments a double decomposition is effected and the glutinous nature of the silicate is destroyed. The whole becomes stiff and crumbly, and the water may be driven off with great ease, while everything except the water is retained.

As all waterglass contains in combination more or less of the earthy silicates which remain as a light sediment after dissolving, the amount of unchanged sand can be found only by resorting to a mechanical separation. For this purpose a quantity of the coarsely ground silicate should be boiled with water till everything soluble is taken up, and then the liquor being stirred and allowed to settle for a moment, may be decanted, carrying with it the suspended silicates. The gritty residue left after one or two washings conducted in the same way, represents pretty nearly the amount of uncombined silex.

[To be continued.]

ART. XVII.—*Sketch of the Distribution of Forest-trees in Nebraska Territory;* by JAMES T. ALLAN. (In a letter to Prof. GRAY.)

THE relative proportion of the several species and their general distribution in the tract of country lying west of the Missouri and between the paralells 40° and 43° is all that I will attempt to describe in this sketch.

And one remark will apply to all this country, that timber is found only upon streams or small groves about some spring on the wide prairie.

The valley of the Missouri is from three to six miles wide, and sometimes the stream winds down near the centre with both sides fringed with willows, behind which is a belt of cottonwood (*Populus monilifera*); these trees often 80 to 100 feet high: upon the bluffs which wall each side of this valley we find the different varieties of hard wood, also upon the hills, and ravines opening toward the river. On the tops of these hills we find *Quercus alba* and *rubra*, with occasional trees of *Quercus coccinea;* half way down the steep sides of these ravines we find *Tilia Americana* and *Ulmus fulva* in about equal quantities, with clumps of *Carpinus Americana*. Still lower down and in the rich soil at the bottom are *Gymnocladus Canadensis*, *Celtis occidentalis* and *Fraxinus Americana*, while on the cool northern slope half hanging down the hill are plenty of *Staphylea trifolia* and *Rubus occidentalis*. As we recede from the river toward the summit of the ridge we find scattering trees of *Carya alba* among the Oaks before mentioned, till we come to the prairie where the trees

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terminate with a few "Scrub Oaks," 12 to 20 feet high, standing beyond the fringe of *Corylus Americana*. Among the latter in the spring we discover the bright blossoms of the Red bud (*Cercis Canadensis*) and in autumn the bright seed-pods of the *Euonymus*.

Going west from the Missouri we find no trees except on the small streams on which, at intervals of ten miles or more are groves of White oak, Bur oak, *Carya glabra* and sometimes White elm; these groves will average in extent from 100 to 500 acres, and the above mentioned, with *Juglans nigra*, make up their prominent trees.

The valley of the Platte, to which so much attention is now directed as the great central route, demands a notice. At the mouth we find a heavy body of timber, chiefly Cottonwood, with a small proportion of *Acer rubrum* and *Morus rubra*. As we proceed up 20 miles the dull green of *Juniperus Virginiana* begins to be seen, which farther up we see covering some of the small islands, with trees often 18 inches and more in diameter. This has furnished for a hundred miles or more telegraph poles of a superior quality.

Upon the tributaries of the Platte, particularly on the north side *Quercus macrocarpa* is the most abundant of large trees.

After leaving Fort Kearney, the immigrant finds but a fringe of cottonwoods skirting the stream, and on the road to the new gold mines for 200 miles not a tree for shade or wood: the well known "Buffalo chips" must supply the latter. Upon the North Platte the emigrant to California or to the Mormon "Zion" is always in sight of the trees bordering on the stream, though often too far off to obtain fuel. 400 miles beyond Ft. Kearney is found in several places large groves of *Negundo aceroides* on the banks of the creeks.

After passing Fort Laramie the pleasant sight of green pines, though at a distance, relieves the eye and tells of the cool waters in the south pass, so refreshing in the heat of summer.

The very rapid growth of trees in this rich soil is a noticeable feature. The hazel which fringes the timber on the prairie side is interspersed with abundance of saplings *Carya alba* and *glabra* and *Alnus fulva*, which shoot up with wonderful rapidity, while upon the sand bars of the river, as soon as the waters subside in July, there spring myriads of young cottonwoods and willows. Of the latter I have neglected to speak though they cover no inconsiderable portion of the valleys of the Missouri and Platte. Everywhere fringing the streams, and where there is a tract annually overflowed by the spring rise there we find a dense growth often 20 to 30 feet high and from one to three inches in diameter growing so thickly that it is impossible without great difficulty to force a passage through them.

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The relative proportion of the several species may perhaps be set down as follows:

1. *Populus monilifera.*
2. *Quercus macrocarpa.*
3. *Quercus alba* and *Quercus rubra.*
4. *Tilia Americana, Ulmus fulva* and *Quercus discolor.*
5. *Juglans nigra, Ulmus Americana.*
6. *Carya alba, Carya glabra.*
7. *Fraxinus Americana, Celtis occidentalis.*
8. *Juniperus Virginiana, Platanus occidentalis.*
9. *Acer rubrum, Gymnocladus Canadensis.*

Besides the above mentioned, of the smaller varieties there are *Prunus Americana, Zanthoxylum Americanum, Staphylea trifolia, Negundo aceroides, Corylus Americana, Carpinus Americana, Alnus incana, Euonymus Americana, Cercis Canadensis, Cornus sericea?*

In the Omaha land district, which contains something like 4000 square miles of land, there appears from the plots in the office to be about 75,000 acres of timber. A tract of country of equal size lying west of it would contain much less.

The botanical names above correspond to and have been compared with the descriptions in Gray's "Manual."

Omaha, Nebraska, April 2, 1861.

ART. XVIII.—*Remarks on the Age of the Goniatite Limestone at Rockford Indiana, and its relations to the "Black Slate" of the Western States, and to some of the succeeding rocks above the latter;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey.

IT is known to most of those who have studied the geology of the west, that there is an outcrop of limestone near Rockford, Indiana, usually termed the Rockford Goniatite bed, in regard to the age of which there is some difference of opinion amongst geologists. This rock is only exposed at a single locality in the bed of a small stream, where not more than a thickness of two feet of it is seen. It is a mottled brownish and ash-colored argillaceous limestone, and contains, in addition to the *Goniatites* from which it takes its name, other fossils belonging to the genera *Nautilus, Orthoceras, Pleurotomaria, Euomphalus, Spirifera, Rhynchonella,* &c.

No other rock is seen above or below this at the Rockford locality, but in sinking wells in that vicinity it has been ascertained that it rests upon a Black Slate forming a marked horizon

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in several of the Western States. Owing to the fact that this slate has been seen to form the bed the same stream at another place about one mile above, and at a slightly higher elevation, it has been supposed that the Goniatite bed is intercalated in it, and the mystery has been that the fossils occurring in the limestone have a decidedly Carboniferous aspect, and in some instances have even been considered actually identical with well known European Carboniferous species; while the Black slate has been referred by Prof. Hall of Albany, New York, to the horizon of the Marcellus shale of the N. Y. series, occupying a position far down in the Devonian, at the base of the Hamilton Group.* In addition to this, Prof. Hall also refers a rather extensive series of fine arenaceous, and more or less argillaceous deposits, holding a position above the Black slate near Louisville, Ky., and at other localities in the west, to the Portage and Chemung Groups of New York, higher members of the Devonian, which are in New York overlaid by a great thickness of upper Devonian strata equivalent to the Old Red Sandstone, of the British geologists.

Without attempting to give a detailed statement of the opinions that have from time to time been expressed in regard to the age of the Black slate and overlying strata alluded to, we would remark that the most generally received opinion amongst western geologists has been, that the whole series known in Indiana and Kentucky as the "Fine-grained sandstone of the Knobs," down to the Black slate, should be included in the Carboniferous system, and some even include the latter also in the Carboniferous.

When the distinguished French geologist, DeVerneuil, was in this country in 1846, he made an excursion through the Western States for the purpose of studying our rocks, and obtained a fine collection of their characteristic fossils. After his return to Europe he published a highly interesting memoir on the parallelism of American and European formations, in which he referred all the fine arenaceous and shaly beds holding a position between the Black slate and the Carboniferous limestones in Indiana, Kentucky, and Tennessee, as well as a portion of the Waverly sandstone in Ohio, to the Carboniferous system. One of the *Goniatites* given to him by Dr. Owen from the Rockford limestone, he considered identical with *G. rotatorius* of Koninck, a well known Lower Carboniferous species, which led him to refer the limestone from which it was obtained to the lower Carboniferous. The Black Slate, however, he referred to the horizon of the Genesee slate of the New York series.†

* See Proceed. Am. As. Geol. and Nat., p. 267, vol. i; also Rept. 4 Dist. N. Y. Geol. Survey, p. 519.

† See Bulletin Geol. Soc. France, vol. iv, 2d Series.

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After the publication of this paper, Prof. Hall was for a time inclined to concur, at least in part, with De Verneuil's views, but he subsequently returned to his former opinion, which he has continued to maintain, with his usual zeal and ability, to the present time. In an important paper recently published by him in the 13th Annual Report of the Regents of the University of New York, he describes a number of fossils from the Rockford Goniatite bed, along with others from the Marcellus shale in New York, and refers not only the Black slate, but the Rockford limestone, which has been supposed to be intercalated in it, to the horizon of the Marcellus Shale.

As the question in regard to the age of the Rockford goniatite bed has an important bearing on the parallelism of our rocks with established horizons elsewhere, we have, while investigating the fossils in the Illinois State Geological collection, carefully compared them with a series of specimens from Rockford, Indiana, in order to determine whether or not the Goniatite bed at that place is represented in our state, and if so, what relations it bears to our other rocks. These comparisons have led us to the conclusion that it is represented in Illinois, as well as in Missouri and Iowa, and that it holds a much higher stratigraphical position than that assigned it by Prof. Hall.

In the first place, we should remark that there is no evidence whatever, that the rock under consideration is overlaid at Rockford, or at any other locality, by any part of the Black slate, though we know the slate occurs beneath it there, as well as in Illinois.

Again after a careful study of a series of the Rockford fossils, we have clearly satisfied ourselves that the limestone from which they were obtained is of the same age as the Chouteau limestone of Prof. Swallow. The evidence of this is the positive identity of at least six of the 23 or 24 known Rockford species, with characteristic forms of the Chouteau limestone in Missouri and Illinois, while most of the others are either identical or closely allied. The following is a list of the species from Rockford which are known to be identical with Chouteau limestone species found in Missouri and Illinois, viz:—*Nautilus digonus*, Meek and Worthen, *Euomphalus lens*, Hall, *Rhynchonella Missouriensis*, Shumard, *Spirifera Cooperensis*, Swallow, (=*S. semiplicata*, Hall) *Cardiopsis radiata*,* Meek and Worthen, (=*Megambonia Lyoni*, Hall,) and *Sphenopterium enorme*, Meek and Worthen.

* We placed this species at first, provisionally, in the genus *Cardiomorpha* of Koninck, but suggested at the same time that we suspected it to be generically distinct. Later examinations have satisfied us of the correctness of this suggestion, and we have proposed to establish for its reception a new genus, under the name of *Cardiopsis*, from its resemblance to *Cardium*. It has no near relations to the type of the genus *Megambonia*.

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In classifying the rocks of Missouri, Prof. Swallow, (and his assistants, including one of the writers) knowing that his Chouteau limestone holds the same position, and contains many of the same fossils found in beds elsewhere in the west referred by Prof. Hall to the Chemung group, placed it on a parallel with the Chemung, and Prof. Hall has also since referred equivalent beds in Iowa to the same horizon.

In order that the reader may understand more clearly the position of the Chouteau limestone with relation to our other western formations, we give below a section showing the order of succession of the several beds, beginning with the Burlington limestone, which is acknowledged by all to be Carboniferous, and extending down to the Hamilton Group inclusive:—

1.—Burlington limestone attaining a thickness of	200 feet.
2.—Chouteau limestone,	100 "
3.—Vermicular sandstone and shale,	65 to 100 "
4.—Lithographic limestone (rather local),	60 "
5.—Black Slate,	30 to 40 ft.*
6.—Hamilton group,	120 "

Numbers 2, 3, and 4 of this section were included by Prof. Swallow in the Chemung, though Prof. Hall thinks that at least a part of the Lithographic limestone, should be referred to the Hamilton group. It is true a few of the many fossils found in the Lithographic limestone resemble Hamilton forms, and one of them seems to be undistinguishable from *Orthis Vanuxemi*, of Hall, a common Hamilton group species. It is well known, however, that many of the other fossils found in this limestone occur in the Chouteau beds above, where they are sometimes mingled with Carboniferous forms. At the same time, unless the *Orthis* just mentioned is an exception, not one of the species occurring in the Lithographic limestone and the Chouteau beds above, can be, so far as our knowledge extends, positively identified with any of the numerous well marked Hamilton forms in the beds below the Black slate.

In regard to the occurrence of the *Orthis* which seems to be undistinguishable from *O. Vanuxemi*, in the Lithographic limestone, we would remark that we do not think it a fact entitled to much weight, when it is borne in mind that *O. Vanuxemi* is so very closely allied to the Carboniferous *O. Michilini* of L'Eveille, that even Mr. Verneuil regarded them as scarcely distinguishable, and the differences between them have not yet been clearly defined. Prof. Hall acknowledges that it "is so closely allied to *O. Michilini* of L'Eveille, that it is

* In some parts of Ky. and Indiana, the Black slate attains a thickness of about 100 feet.

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very difficult to point out characters by which it may be distinguished." He thought, however, that, judging from DeKoninck's figures of *O. Michilini*, he could see some slight differences in the vascular impressions and dental processes, and remarked that the "minute granulations or punctæ upon the exterior surface [of *O. Vanuxemi*] present characters which are not noticed in the figures and descriptions [of *O. Michilini*] so far as I have observed."* Yet we find in Mr. Davidson's very carefully written description of *O. Michilini*, since published in his Monograph of the Carboniferous Brachiopoda of Scotland, that he says the surface is "covered with minute punctures." In fact almost every word of Mr. Davidson's description would apply equally well to *O. Vanuxemi;* and after a very careful comparison of our western form with authentic specimens of *O. Michilini* from Scotland, sent by Mr. Davidson, we have been unable to find any appreciable differences. We are not, however, contending that they really are identical, but we simply mean to say that it is unsafe to base conclusions upon such closely allied species.

The three subdivisions Prof. Swallow has called Vermicular sandstone and Shale, and the Chouteau limestone above, although often distinctly separable by their lithological characters, seem sometimes to replace each other, or often one is augmented in thickness at the expense of the other, though they are mainly characterized by the same fossils. The whole group is very variable in its lithological characters, the very same beds that are at one place composed of hard bluish or ash-colored compact limestone, being at others a yellowish very fine soft argillaceous, or arenaceous rock, or consisting of alternations of brownish and greenish shaly limestone, &c. The fossils are usually in a better state of preservation in the limestones than in the other beds, and assume a more decided Carboniferous aspect than in the arenaceous and argillaceous strata, even where the latter occur above the limestones.

The Black slate, so far as our knowledge extends, seems to be nowhere greatly developed in Missouri, though it is probably represented at Hannibal in that state by six feet of blue shale beneath the Lithographic limestone, as may be seen by Prof. Swallow's Section No. 15, p. 99, of the Missouri Report. Some eight or ten miles east of Hannibal, in Illinois, it is seen occupying the same position with relation to the Lithographic limestone, and attaining a thickness of thirty or forty feet.

Although the position of the well marked Hamilton beds with relation to the representative of the Black slate, have probably not been very clearly determined in Missouri, they are there

* Tenth Ann. Rept. Regents University of N. Y., p. 136.

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known, as Prof. Swallow has shown, to hold a position beneath the Lithographic limestone. In Illinois, however, numerous exposures show that the black slate comes in just above all the well defined Hamilton Group beds as may be seen by the following section taken near Jonesborough, Union county, Illinois:—

1. Brown silicious shale probably representing the Vermicular sandstone and Shale of Prof. Swallow,	50 to 60 ft.
2. Black Slate with its characteristic *Lingula*,	40 to 50 ft.
3. Hamilton group, consisting of a dark limestone, containing *Phacops bufo? Strophomena Hamiltonensis*, *Trepidoleptus carinatus*, *Heliophyllum Halli*, and other well known Hamilton species, along with *Atrypa reticularis*, &c.,	120 ft.

Now as the Chouteau limestone of Prof. Swallow, is known to hold a position immediately beneath the Burlington limestone, and considerably above the horizon of all the Hamilton group beds of the West, as well as above the Black slate, which also overlies the Hamilton group in Illinois, it follows as a matter of course, that its representative in Indiana, the Goniatite bed at Rockford, cannot belong to any part of the Marcellus shale, lying at the base of the Hamilton group.

Again, the fact that all our well marked Hamilton beds in Illinois, hold a position beneath the Black slate, while in New York, as already stated, the Marcellus shale lies at the base of the Hamilton Group, renders it very improbable that even our western Black slate formation represents the Marcellus shale. Its position would seem to be more nearly that of the Genesee slate of New York, as suggested by M. DeVerneuil, which supposition is strengthened by the affinities of the only fossils yet found in it, viz,—a small *Lingula* and a *Discina*, scarcely, if at all, distinguishable from species occurring in the Genesee slate of New York, to which in fact they were referred by Prof. Yandell and Dr. Shumard in 1847.

Although Prof. Hall describes about twenty species of fossils from the Rockford *Goniatite* bed, it will be observed that he does not identify any of them, with Marcellus shale species, or with forms occurring in any other part of the Hamilton group either in New York or in any of the Western States; but refers the rock in which they occur to the horizon of the Marcellus shale, solely from the fact that it was thought to be intercalated in the Black Slate, and from the supposed affinities of its *Goniatites*, to Marcellus species. Aside, however, from the evidence we now have that the Rockford limestone is of the same age as the Chouteau limestone of Missouri, which comes in some distance above

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the Black slate, and is exactly equivalent to beds referred by Prof. Hall at Burlington, Iowa, to the Chemung, its whole group of fossils including the *Goniatites*, strike us as being more nearly allied to Carboniferous forms than to those of any of the New York rocks.

If we take for instance the three species of *Goniatites* now known from the Rockford bed, we find first that *G. Lyoni*, Meek and Worthen, (=*G. hyas* of Hall,) which Prof. Hall compares with *G. Chemungensis*, of Vanuxem, differs materially from Vanuxem's figure of that species, in having but two lobes in each septum visible on either side, while *G. Chemungensis* is figured as having five. It bears no near analogy whatever, to any of the species figured by Prof. Hall, from the supposed equivalent bed in the Marcellus shale of New York.

Again *Goniatites Oweni* of Hall,* is much more closely allied to *G. princeps* of Koninck, (a European Carboniferous species) than it is to any of those yet known from the Marcellus shale, or any other rock in New York. It agrees in size and form with Koninck's species, as well as in having constrictions at intervals left upon its internal cast by the occasional thickening of the lip, while it presents but slight differences in the lobes of its septa; the most obvious difference being in the length of its dorsal lobe, which is more attenuated than in *G. princeps*, though even in this character, the Rockford specimens vary to some extent. It is true *G. princeps*, as figured by Mr. Koninck, is marked by regular costæ, while *G. Oweni*, as we usually see it in the condition of worn casts, seems to be smooth. We have, however, seen unmistakable traces of similar costæ, on some of the Rockford specimens. We are not contending, however, for the absolute specific identity of these forms, but we do maintain that the analogy of the Rockford species to *G. princeps* is much nearer and more striking than its relations to any of the Marcellus shale species.

The third species, *Goniatites ixion* of Hall, while it presents but very remote analogy to any of the Marcellus shale species, is scarcely, if at all distinguishable from the Carboniferous species, *G. rotatorius*, of Koninck,† with which Mr. Verneuil considered it identical. They may possibly belong to different species, yet the minute differences pointed out by Prof. Hall, are, we think, not inconsistent with specific identity in a genus like this. Every one who has studied the *Ammonitidæ* must be aware how unsafe it is to base specific distinctions on minute differences in the smaller details of the lobes of the septa, or upon slight differences in the size of the umbilicus. We are

* See thirteenth Ann. Report Regents University New York, p. 100.
† Animaux Foss., pl. 51, fig. 1.

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not insisting, however, upon the exact identity of these forms, for that is a question that can only be settled by direct comparison with authentic specimens of the European species; yet that they are at least strikingly analogous, must be evident to any one who will but glance at Prof. Hall's, and Prof. DeKoninck's figures.

If we compare the two species of *Nautilus* now known, from the Rockford beds, *N. digonus*, and *N. trisulcatus*, Meek and Worthen, we find them wholly unlike any forms known in the Marcellus shale, while the latter species is allied to the Carboniferous *N. sulcatus* of Sowerby, (see Koninck's An. Foss., pl. xlvii, fig. 10), and the former is analagous to two or three of the species figured by DeKoninck from the Carboniferous rocks of Belgium. In fact both of these species belong to a peculiar subgenus of *Nautili* for which we have proposed the name *Trematodiscus*, a group embracing a number of discoid Carboniferous species, with a wide perforated umbilicus and narrow whorls, which are ornamented with longitudinal angular ridges, and sometimes with parallel striæ. So far as we know, the entire group is confined to the Carboniferous system, unless those found in the Rockford *Goniatite* bed and its equivalent in Illinois, are exceptions.*

In order to show the close relations between the Chouteau limestone and the Burlington (acknowledged Carboniferous) beds above, in Illinois, we might give many sections, with lists of fossils, but the following taken near Grafton in Jersey county, will be sufficient for illustration:—

1.—Burlington limestone,
presenting its usual characters and containing its usual fossils; showing at the immediate outcrop where the section was taken, a thickness of 8 to 10 feet, but increasing as the country rises back to a thickness of 150 or 200 feet.

2. Chouteau limestone.
Upper part consisting of ash-colored argillaceous shelly limestone in thin lares, with greenish marly partings and calc spar concretions. Containing *Cyathoxina* (undt. sp.), *Poteriocrinus Meekinus*, *Actinocrinus* (undt. sp.), *Spirifera peculiaris*, *S. grimesi*, *Athyris Prouti*, *A. Hannibalensis*, *Strophomena rhomboidalis*, *Orthis Michilini*, *O. resupinata*, *Productus semireticulatus*? *Platyceras equilatera*, - - - - - - - - - - 40 feet.

* The forms included in this subgenus differ so widely from the recent typical species of *Nautilus*, that few conchologists would place them in the same genus if they were found living in our present seas. It includes such species as *N. pingius*, *N. stygialis*, *N. Edwardsianus*, and *N. Omalianus* of Koninck, and *N. sulcatus*, and *N. cariniferous* of Sowerby. *Gyrocerus gracile* of Hall, from the Rockford limestone probably also belongs to this group.

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Lower beds, composed of brownish-buff colored argillaceous limestone, with nodules of calc spar, the upper part being in thicker beds than the lower which has a more greenish tinge. Fossils—*Strophomina rhomboidalis, Chonetes ornata, Cardiopsis radiata, Productus semireticulatus? Cyrtoceras* and *Gomphoceras* (undt. sp.) *Nautilus digonus*, a discoid *Goniatite*, and a *Proetus* (undt.) - - 60 feet.

3.—Black slate shading upwards to greenish shale, - - 40 "

4.—Hamilton group, consisting of dark limestone, - - 10 "

5.—Niagara group limestone of buff col., - - - - 100 "

Of the fossils mentioned in the above section the following are usually characteristic of the Chouteau series:—*Cyathoxina* (undt.), *Poteriocrinus Meekianus.** *Spirifera peculiaris, Athyris Prouti, A. Hannibalensis, Chonetes ornata, Cardiopsis radiatus, Nautilus digonus*, and an undetermined *Goniatite*. Those usually regarded as strictly Carboniferous are,—*Spirifera Grimesi, Orthis Michilini, Productus semireticulatus*, and *Platycerus equilatera*.

The forms common to Carboniferous and Devonian rocks, are *Strophomena rhomboidalis*, and *Orthis resupinata*. The species here enumerated, however, are only those collected at the locality where this section was taken. Several other Carboniferous forms are sometimes found in the Chouteau beds at other places, and a number of other Chouteau species are known to range up into the Burlington beds. From a locality in an adjoining county, we have an *Actinocrinus*, from the Chouteau series, which we can only distinguish as a variety, from the well known Burlington *A. pyriformis* of Shumard; and along with it we also find a species of a peculiar coral (*Sphenopoterium enorme*) described by us from the Rockford Goniatite bed.

In an interesting and important paper on the rocks and fossils of Burlington, Iowa, published by Mr. Charles A. White of that place, in the Boston Journal of Natural History, (vol. vii, p. 209) he shows that out of a list of one hundred and two described species occurring in the Burlington limestone, fifteen commenced their existence in the beds below, referred by Prof. Hall to the Chemung; which as is well known, represents the Chouteau limestone of Prof. Swallow.

When we thus find these beds so intimately connected by the general affinities of their organic remains, as well as by the actual mingling of species with the undoubted Carboniferous rocks above, and bear in mind that the Chemung group in New York and Pennsylvania, is surmounted by another Devonian formation, (the Old Red Sandstone) between two and three thousand

* At the time Dr. Shumard described this crinoid, its exact geological position was not known, the specimen having been found loose at the base of a bluff composed in part of the Chouteau beds, and partly of the Burlington limestone. Its true position has since been determined to be in the Chouteau limestone, though it probably also ranges up into the Burlington limestone in some places.

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feet in thickness, the questions naturally suggest themselves,—are we right in referring these Chouteau beds to the horizon of the Chemung? Can it be possible that a great formation like the Old Red Sandstone, characterized by the remains of a peculiar fauna of its own, is wanting here between the Chouteau and Burlington limestones?

But on the contrary, it may be said, if we do not adopt this conclusion, what are we to do with the fossils occurring in these rocks apparently identical with Chemung species? In reply to this latter question, we would state that although we have for a long time thought a few species occurring in the Chouteau beds identical with Chemung forms, later comparisons with New York specimens from the latter formation, lead us to doubt their actual specific identity. They are generally obscure casts of *Avicula* and other lamellibranchiate mollusca, some of which also resemble Carboniferous species. Admitting, however, that they are undistinguishable from Chemung species, does their presence here in the same beds with numerous other fossils totally distinct from Chemung forms, and not only more nearly allied to Carboniferous species, but in some instances identical with those occurring in acknowledged Carboniferous strata above, warrant us in placing these beds on a parallel with the Chemung group?

Mr. White, in discussing this question in his paper already cited above, says, "admitting that some of the species found in the lower beds have been identified with those of the Chemung group of New York, it settles beyond question their geological equivalency, but does not necessarily prove that they were contemporaneous. Indeed, it seems probable that they were not so, by an interval of time that it would take the species to migrate that distance. May it not, therefore, be inferred that the species originated at the east, and were migrating westward during the time that the bottom of the Chemung seas was sinking, and receiving upon it the deposit of the Old Red Sandstone,—thus making these Devonian rocks equivalent to the Chemung of New York, and contemporaneous, at least in part, with the Old Red of the Katskill Mountains?"

If any of the species found in the strata under consideration are really identical with Chemung forms, as has been supposed, Mr. White's suggestion that they had prolonged their existence by migrating westward, until long after the close of the Chemung epoch in New York, is not improbable, but in that case, we should not refer the rock in which they occur to the Chemung, but either to the Old Red, or to the Carboniferous, for in using any of these names we refer to a period in time, as well as to a group of strata. The entire group of fossils, however, found in these beds is far more nearly allied to the Carboniferous fauna than to that characterizing the Old Red either in this country or

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in the Old world; in short we know of nothing in this formation bearing any analogy to the fossils of the Old Red sandstone.

In conclusion, we would remark that the relations between the Chouteau and Burlington limestones in Missouri, Iowa, and Illinois, where both occur together, as well as the affinities of the fossils found in the former in the states mentioned, and at Rockford, Indiana, show that it should probably be referred to the Carboniferous system; or, at any rate that it is much more recent than the Chemung, and not equivalent to any New York rock.

It is not improbable, however, that the Portage and Chemung groups may be represented between the Chouteau limestone and the horizon of the Black Slate, at some places in the Western States alluded to, but if so, their presence there has yet to be clearly demonstrated.

Art. XIX.—*Chemical Contributions;* by M. Carey Lea.

1. *On the Preparation of Nitrate and Nitrite of Ethyl.*

NITRATE OF ETHYL.

The tendency of alcohol to decompose nitric acid is so great that while we have any number of processes for obtaining nitrite of ethyl, Millon's is the only one known for forming the nitrate. But Millon's process fails much oftener than it succeeds (such at least has been my experience) in consequence of the proportion of urea directed to be used being much too small.

Millon's process as quoted in Kolbe's Organische Chemie, directs to distill equal weights of alcohol and of colorless nitric acid sp. gr. 1·401. Not to operate upon larger quantities than 120 to 150 grammes, and to add a little urea, to the above quantity, at most ("höchstens") 2 grammes of urea.

Conducted as above, the operation succeeded with me but once out of four or five times. But by using a large quantity of urea, three or four times as much, or even more, success invariably follows, and there results a great saving of urea, because when the process fails, the materials, urea included, are entirely lost, whereas when conducted as just described, very little urea is consumed. It is only necessary to add fresh acid and alcohol, after the first proportion has been distilled to about one fifth, and the process may be repeated almost indefinitely, with the occasional addition of a little urea to keep up the proportion. The product in the second and subsequent operations is much larger than in the first.

Nor have I found it necessary to operate on the small quantities above mentioned, but have habitually used quantities

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amounting to 400—500 grammes, and should not hesitate to employ still larger ones. It is however more convenient to use the above quantity, and replace the material as fast as exhausted.

The facility with which nitrate of ethyl can be obtained by the above process must, I think, give it a decided advantage over the iodid of ethyl for the preparation of the ethyl bases, in the manner which I described in the last number of this Journal. The lower equivalent of nitric acid as compared with iodine is a matter of considerable importance, one hundred parts of iodine are capable of holding in combination something less than 23 of ethyl, whereas one hundred parts of nitric acid combine with over 53 of ethyl; a material point as the iodine on the one hand and the nitric acid on the other are merely the vehicles for bringing about the ethyl-substitution. In operations in pressure tubes where space is valuable, this is an important consideration; in an economical point of view also, the advantage appears to be greatly on the side of the nitrate of ethyl.

NITRITE OF ETHYL.

The action of nitric acid on alcohol in the preparation of nitrite of ethyl may be conveniently moderated by protosulphate of iron, and the nitric acid reduced by that agent instead of at the expense of part of the alcohol. The proportions which I have used are, nitric acid sp. gr. 1·37, 90 cc., alcohol of 90 per cent, 150 cc., ferrous sulphate 45 grammes. The product is very large, the distillate on being shaken up with water yields more than half its bulk of nitrite of ethyl. The latter is not perfectly free from aldehyd, but more so than that obtained by some other processes. The action is perfectly quiet to the last, and the distillation may be carried on rapidly.

2. *On the Effects of Reducing Agents upon Nitrite of Ethyl.*

As ammonia under the influence of oxydizing agents is burned to nitrous and nitric acids, so these acids when acted upon by reducing agents, might naturally produce ammonia, or in the presence of a decomposing ethyl compound, might give rise to the formation of substituted ammonias. The experiment however seems to prove that while ammonia is a constant result of this reduction, it varies greatly in quantity according to the particular reducing agent employed, and that substituted ammonias are not produced, at least not in recognizable quantities. The following were the reactions observed:—

Reduction by protochlorid of tin.—Alcoholic solution of protochlorid of tin added to nitrite of ethyl causes violent effervescence, but no disengagement of nitrous fumes. The solution of

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protochlorid was added until reaction ceased. The whole was then distilled with caustic potash and the resulting gases conducted into dilute chlorhydric acid, which by evaporation left only a film of substance—this gave on examination distinct indications of ammonia.

Reduction by sulphydric acid.—A large quantity of sulphydric acid was conducted through nitrite of ethyl. Slight effervescence was produced and much sulphur deposited. The liquid filtered from the sulphur proved to contain a large quantity of ammonia, but no ethylamine, di-, or tri-ethylamine, although the mode of examination employed would have detected a very small quantity if present. After the removal of the ammonia, the solution heated with $PtCl_2$ gave a small quantity of a brown precipitate of a platinum salt, which when heated glowed for a long time showing the presence of much carbon, and finally left a residue of reduced platinum. The amount obtained was too small for investigation, but 20 or 25 milligrammes of Pt. salt were obtained from the decomposition products of 50 grammes of nitrite of ethyl.

This result therefore, as far as to the production of ammonia, corresponds with that obtained by M. Emile Kopp,* although, as that chemist employed sulphydrate of ammonia instead of sulphydric acid, it does not appear that the production of ammonia by the reaction itself, could be positively established.

Reduction by ferrous acetate.—Nitrite of ethyl was added to about three times its bulk of ordinary acetic acid, and sufficient alcohol to make them mix. To this mixture iron filings were added. A powerful action set in without aid of heat. Deutoxyd of nitrogen was evolved in considerable quantity. When action had ceased, the resulting liquid was filtered, evaporated with chlorhydric acid and distilled with caustic potash. The distillate contained only traces of ammonia.

The effect of the reducing agents on nitrite of ethyl is therefore very different. Only with sulphydric acid was any considerable quantity of ammonia produced, and only with ferrous acetate was deutoxyd of nitrogen evolved.

3. *On the Preparation of Urea from Ferrocyanid of Potassium.*

In the preparation of urea by Wöhler's method the amount obtained always falls short of that which should theoretically be produced. Having remarked that even when the operation is

* Gerhardt, *Chimie Org.*, ii, 347.

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carefully performed with Liebig's proportions, the lixiviate always contains undecomposed cyanid of potassium, it occurred to me to try the effect of a more thorough oxydation, and the result proved very favorable. The following was the course adopted.

Of roasted ferrocyanid of potassium 850 grammes are mixed with 318 grammes of thoroughly dried carbonate of potash in grains, and fused in an iron vessel. When decomposition is complete, the vessel is a little cooled and 1900 grammes of red lead are to be added, not all at once, but 300 to 400 grammes at a time, with intervals of 10 minutes, stirring and keeping up heat enough to retain the whole in a state of fusion.

After the last addition of red lead the mixture is suffered to remain half an hour on the fire to complete the reaction. Heat is applied in all for about four hours. In this way the cyanid of potassium becomes thoroughly oxydized. The process is concluded in the usual manner, and 500 grammes of urea are obtained. No particular precaution is necessary during the fusion, or even the lixiviation with cold water, but in evaporating the solutions the greatest care must be taken to carry off the vapors.*

Philadelphia, April, 1861.

ART. XX.—*Contributions to the History of Picric Acid;* by M. CAREY LEA, Philadelphia.

Solubility in Sulphuric Acid.

IT is stated in the text-books that picric acid is insoluble in sulphuric acid. It is however soluble to a small degree in strong sulphuric acid; in a more dilute acid it is apparently wholly insoluble, until the dilution reaches a certain point when it increases again. If picric acid be left in contact with oil of vitriol, and the latter be decanted, and mixed with two or three times its volume of water, the picric acid is deposited on cooling in what appear to be very minute square or nearly square scales.

Picric acid crystallizes in the rhombic system, and if we suppose these scales to be formed by predominating $\infty \bar{P} \infty$ planes bounded at the edges by octahedral planes, they should be rhombs approaching very nearly to squares, having their axes as ·9374 : 1·0000.

If cold saturated aqueous solution of picric acid be mixed with sulphuric acid diluted with an equal volume of water, the following results are obtained:

1 vol. solution of picrate, 4 vols. dilute sulphuric acid. (1 vol. acid, 2 vols. water.)	No precipitate, solution remaining as colorless as water.

* For continuation of Mr. Lea's "Contributions," see p. 210.

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1 vol. sol. picric acid, 2 dilute sulphuric acid, same dilution.	No precipitate, solution very nearly colorless, faintest tinge of yellow only visible.
2 vols. solution picric acid, 1 vol. sulphuric acid, same dilution.	Nearly the whole of the picric acid was precipitated.

The amount remaining in solution continued in further trials to diminish as the sulphuric acid became more dilute, until a maximum was reached with

3 vols. solution picric acid, 1 vol. dilute sulphuric acid, same dilution.	

It thus appears that mixtures of sulphuric acid and water reach their minimum of solvent power for picric acid when the mixture consists of about 1 vol. acid to 11 vols. water. The proportion of water may be still further increased without materially increasing the solvent power for picric acid. If a cold saturated solution of picric acid be mixed with even but $\frac{1}{17}$ of its volume of sulphuric acid, almost the whole is thrown down.

The fact that the characteristic color of picric acid, which it maintains so persistently through all its combinations, and which is so powerful that, as I have found by actual experiment, a milligramm will distinctly tinge a kilogramm of water, or in other words, that water is colored by one millionth of its weight of picric acid—the fact that this color is totally destroyed by sulphuric acid of a certain strength, without in any way decomposing the acid, is very remarkable. Four volumes of sulphuric acid diluted with five volumes of water exhibit this property, and picric acid dissolves in such a mixture to a colorless solution. This peculiar property has no doubt led to the supposition of the insolubility of picric acid in sulphuric acid above referred to.

Water containing $\frac{1}{10}\frac{1}{000}$ of picric acid exhibits a bright yellow color. With $\frac{1}{100}\frac{1}{000}$ the color is still distinct, even in a stratum of not over an inch in thickness. But in large quantities a millionth gives a distinct color as above mentioned.

Tests for Picric Acid.

The best tests for picric acid are

Ammoniacal solution of sulphate of copper, which gives a greenish crystalline precipitate.

Alkaline sulphid with excess of alkali, which with heat gives a deep red liquid.

Alkaline cyanid with ammonia, which when heated gives also a red liquid.

The following table will exhibit the relative sensibility of these reagents:

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Strength of aqueous solution of picric acid.	Ammonio sulphate of copper.	Potash liver of sulphur (heat.)	Cyanid of potassium.
$\frac{1}{1000}$	Immediate precipitate.	Solution becomes sherry wine red.	Pale sherry red, with heat becoming deep red.
$\frac{1}{4000}$	No precipitate at first, but by standing a few minutes a distinct one.	Deep yellow with a tinge of sherry color.	Deep yellow, tinge of sherry color, deepened by heating.
$\frac{1}{5000}$	Distinct precip. by standing.		
$\frac{1}{10000}$	No precipitate.	The yellow color was slightly deepened, the cyanid test is the more delicate of the two.	

Purification of Picric Acid.

Since my former observations on the purification of picric acid,* I have had occasion to prepare considerable quantities of the acid for my examinations and find that all purifications by converting into potash salt are inapplicable except for very small quantities. The picrate of potash crystallizes out by so small a fall of temperature that the filters, even when kept heated by a double funnel become immediately clogged, and the operation becomes to the last degree tedious and troublesome. As the picrate of lime is very soluble, it seemed probable that it might afford a convenient means of solution; it has indeed been already recommended for that purpose.† But I find it wholly inadmissible. A basic salt is formed which falls to the bottom with the excess of hydrate of lime, and great waste ensues. The insolubility of alkaline picrates in cold alkaline solutions which I have described in a previous number of this Journal, furnished me with an excellent process. The crude acid is saturated with carbonate of soda, an excess of which is to be avoided as it tends to dissolve resinous matter. The hot solution is then easily filtered, and into the filtrate a few clear crystals of carbonate of soda are placed. On cooling, the picrate of soda crystallizes out almost as completely as the potash salt would have done, and all the wearisome delay in filtration is avoided. From the mother water more picric acid may be recovered by the addition of a little carbonate of potash. In decomposing alkaline picrates to separate the acid sulphuric, (and not as usually recommended, chlorhydric) acid should be used, because a moderate excess of sulphuric acid throws down a great portion of the acid which would otherwise

* This Journal, Nov., 1858. † See Gmelin, Eng. Ed., vol. xi, p. 214.

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remain in the mother water. A moderate but decided excess of acid is absolutely necessary, because otherwise a portion of alcaline picrate escapes decomposition. Even then, it is advisable to recrystallize the acid from alcohol. If picric acid be dissolved by the aid of heat in a solution of sulphate, nitrate, or almost any salt of potash, more or less picrate of potash will crystallize out on cooling. I have thought this process not devoid of interest, because picric must become more extensively known in the laboratory and in the arts than hitherto.

Effect of Reducing Agents.

The effects of reducing agents when alkali is not present, or not present in excess, (in presence of excess of alkali, picramic acid is formed), are very variable, depending upon slight differences which it is very difficult to seize. I subjoin some of the best marked results obtained.

A mixture of picric acid, alcohol, iron filings, and acetic acid, were digested for an hour at a heat a little below 212°. The filtrate was intensely blue, by standing for half an hour or less, became brown and muddy, depositing a blackish powder, in small quantity, and without trace of crystallization. This filtrate was not changed in color by acids, or apparently affected by them. Alkalies decolorized it. Its shade of blue varied considerably in different experiments, sometimes full blue, sometimes violet, sometimes greenish.

Other experiments were made by acting on picric acid by zinc and dilute sulphuric acid. After an action of some hours, the solution was mixed with alcohol and filtered. The filtrate heated with bicarbonate of potash in successive portions, gave a fine violet liquid, which with further addition of alkali became deep blue with a tinge of violet. According as acid or alkali were present in excess there was more of the violet or blue shade. The colors were always very fugitive, and changed to dirty brown by standing, with deposit of an amorphous blackish powder, (very small in quantity compared with the picric acid used,) which was soluble in acids, and insoluble in alcalies.

These experiments although many times repeated did not lead to the isolation of any substance of interest. There is a certain amount of resemblance between these reactions, and those of some of the decomposition products of phenylamine: the latter contains the radical $C_{12}H_5$ which exists in a substituted form in picric acid.

Philadelphia, April, 1861.

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ART. XXI.—*On the Relation between our Perception of Distance and Color;* by Prof. O. N. ROOD.

THE fact that a landscape appears more vivid in color, when viewed by the eyes brought into an abnormal position, as in looking under the arm, &c., is well known.

Some persons have attempted to explain this fact by the influence of an augmented pressure of the blood upon the retina.

In an easy reclining posture, where such pressure can hardly exist, I observe this heightening of tints with great distinctness, also by viewing the inverted image of the landscape by total reflexion through a rectangular prism, the head being in its natural position.

Dr. A. Müller* with more probability has referred this appearance to the different accommodation of the eye for horizontal and vertical lines.

To me it seems that this effect is intimately connected with our perception or non-perception of distance. In gazing at landscapes, the ordinary habit of most persons, artists excepted, leads them to pay attention to the forms and *distances*, (which alone have a practical value as objects of observation), and to neglect the *color*, particularly those portions of it which are subdued. When now by any means the mind is prevented from dwelling on distance, it is thrown back on the remaining element, color; and the landscape appears like a mass of beautiful patches of color heaped upon each other, and situated more or less in a vertical plane.

(1.) A perpendicular position of the eyes reduces very considerably our perception of depth or distance, so that false estimates of it are formed by the eyes in this new situation. With the exception of objects in the foreground, all things seem to lie not far removed from the same vertical plane.

The reason is partly to be found in the fact, that while in normal vision our binocular perception of depth is obtained by regarding vertical lines, trees, &c., in vertical vision the same objects, though instinctively sought afford us no information.

(2.) In normal vision with a single eye, there is certainly, in a binocular sense no perception of depth, nevertheless the mind occupies itself with the idea of distance, and if the objects are familiar there is no augmentation of color perceived. By inverting the image of the landscape with a rectangular prism the objects fall into almost one plane, are diminished in apparent magnitude, and the mind unable to trace distances through this maze, is forced to dwell on the mass of tints presented.

* Pogg., vol. lxxxvi, p. 147.

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(3.) With the erecting or inverting telescope, in proportion as the objects viewed are divested of the idea of solidity or depth, can their more delicate tints be perceived. Objects, which in normal vision seem to us nearly without color, are best fitted for these observations; a bare pile of stones and dry mud viewed through a telescope appears often like a richly tinted water color drawing.

It would seem probable that if we could add to paintings of landscapes the element of distance, the mind occupied with this would no longer dwell on the richness of the tints. In confirmation, I find that colored stereographs of landscapes, which out of the stereoscope seem exaggerated in tint, when placed in the instrument no longer appear too highly colored.

From the foregoing considerations, then, it would appear that when the mind is engaged with the perception of distance, the *presence* of color is often overlooked; its *absence* may remain unnoticed from the same cause, for in uncolored stereographs of objects that are perfectly familiar to the observer, it will sometimes be noticed, that those articles which do not greatly differ in color from the tint of the photographic paper, are seen in the stereoscope with an approximation to their natural hues; upon withdrawing the slide from the instrument no trace of such tint is perceived. Objects that are free from lustre, as well known carpets, answer for this purpose. That this should be the case with the tinted photographic representations of white objects can be explained of course in another way.

[The chromatic effects here noticed by Prof. Rood are well seen in the ordinary camera and dark chamber. Thus the human countenance when not florid, presents to the unartistic eye few or no traces of pink or flesh color—but every one who has seen it in the camera must have observed with what distinctness the image is colored. The same is true of familiar landscapes, when seen inverted upon the screen in a dark chamber. Here the neutral tints which in nature are almost unnoticed by the common observer, stand out as distinct patches of color in the way so well described by Prof. Rood.—S.]

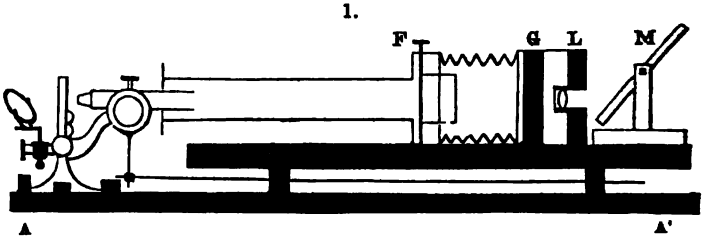
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ART. XXII.—*On the Practical Application of Photography to the Microscope;* by Prof. O. N. ROOD, of Troy, N. Y.

WHILE the value of the photographic delineation of microscopic objects, as a means of accurately recording observations, seems to be generally acknowledged, yet owing to the real or imaginary difficulties with which the process is beset, but very few working microscopists have adopted it.* After eight months of steady experimental work on the subject, this fact appears to me a matter of astonishment, for the difficulties which are not inherent, mostly disappear when proper precautions are taken. I propose to mention briefly certain points in my experience, and to indicate the methods pursued.

Arrangement of the Apparatus.—The microscope is brought into a horizontal position, and connected with a camera box by a blackened paste board tube; much vexation will be avoided by constructing at the outset the arrangement seen in the wood

1.



cut, fig. 1. Blocks are fitted around the foot of the microscope, that it may be firmly held in position, and the camera box slides between parallel strips of board, so that its distance from the microscope can be varied. The length of A A′ is seven feet. The frame holding the ground glass slides in at G; behind it at L, is a door on hinges carrying an achromatic lens of two inches focal length, for the purpose of magnifying the image on the ground glass while focusing; the glass plate should be finely ground. A tube lined with black velvet is to be inserted

* In Vienna microscopic photographs have been produced under the direction of AUER. POHL and WESELSKY have also worked at this subject. (*Sitzungsbericht d. Kais. Akad*, 1857, xxiii, vol. 1, page 317); at an earlier date MAYER of Frankfort obtained fine photographs of this kind. BERTSCH presented similar results to the French Academy (*Comptes Rendus*, 1857, xliv). NACHET also obtained good results HODGSON (*Quart Journ. of Micros. Science*, 1853, ii, p. 147), DELVES, (3d No. of the same, p. 57), SHADBOLT (ibid, p. 165), HUXLEY (ibid, p. 178 also No. 4, p. 305), WHENAM (same Journal, 1855, No. 10, p. 1), and KINGSLEY (*Phil. Mag.*, 1853, June, p. 461), have published accounts of their more or less successful results. HARTING on the Microscope, *Braunschweig*, 1859. To the above must be added the great work now being issued in numbers in Munich entitled *Atlas der allgemeinen theirischen Gewebelehre, herausgegeben von* TH. V. HESSLING *und* J. KOHLMANN, *nach der Natur photographist von* JOS. ALBERT.

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in the compound body, as recommended by Shadbolt, if the eye-piece is not employed. Precautions must of course be taken that light does not enter at unguarded points. At F is a rod connected with a flap of blackened sheet brass in the interior of the box, with which the exposure of the sensitive plate is very conveniently effected. It is obvious that while the operator is manipulating the mirror, or using the stage movements, on account of the length of the apparatus it is impossible for him to see the ground glass, or even to know when light has been thrown on it; a plane mirror, mounted as seen at M, reflects the image of the ground glass, enabling him not only to arrange the illumination with nicety, but to select the microscopic object, and to focus on it approximately. While the mirror is in use the door carrying the achromatic lens stands open; the mirror is afterwards removed and the focal adjustment completed with the help of the lens, by the rod and lever attached to the rack work of the microscope. If the rack work is moderately good, this arrangement is very delicate. When a high magnifying power is employed, it is essential that the microscope be provided with stage-movements to bring the object into its proper position. The lever stage is not to be recommended for this purpose.

Illumination of the object.—That direct sunlight is greatly to be preferred is admitted by those who have experimented on this point. With light from a white cloud I have obtained negatives, in from one to three minutes, with 1 inch and $\frac{1}{8}$ inch objectives; though not highly magnified, they were inferior to those taken with sunlight. Shadbolt obtained negatives by concentrating the light of a small camphene lamp on the object with two lenses. Whenam in repeating this experiment met with no success. I concentrated the light of two flames of a "burning fluid" lamp with a bulls-eye-condenser on the object, employing the 1 inch objective without an eye-piece, and obtained, with several samples of collodion from different manufactures, absolutely no image at all, after an exposure of five minutes. With samples prepared by myself tolerably intense negatives were obtained in four minutes. With the $\frac{1}{8}$ inch objective a faint image was obtained in the same time. For my own work direct sunlight is always employed.

It is well known that the proper display of microscopic objects, requires that great attention should be given to their illumination, not only in degree, but in kind; much has been written on this subject and an astonishing amount of labor bestowed on it. All this applies with double force to the illumination preparatory to the introduction of the sensitive plate; refined methods here find a most useful application. If the power employed be under 100 diam., the plane or concave mirror will answer, if the

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stage be provided with a diaphragm-plate having apertures of different size. The mirror should be most carefully adjusted, so that the maximum of distinctness in the image on the ground glass is obtained. I was kindly furnished by Prof. Chas. A. Joy with a *silvered* mirror which Liebig presented to him some months ago while on a visit in Europe. It furnished brighter light than the ordinary amalgam mirror; the use of Liebig's mirrors for this purpose, as well as for ordinary microscopic work is to be recommended. With powers from 100 to 2000 diameters, a condenser of some form is needed. For powers from 100 to 400 diameters, an achromatic condenser adjustable by rack work was used. Such a condenser must be provided with a series of diaphragms having circular apertures differing in size, also with a set of central stops for annular oblique illumination.

Trial alone will settle which aperture gives the clearest image in any particular case. As the lenses of this condenser were not large, I constructed for powers from 400 to 2000 diameters a Wollaston doublet, with an angular aperture of 44°, the lenses being ·5 and ·6 of an inch in diameter. This condenser when provided with a similar set of diaphragms was found to answer very well, both as to the degree and quality of the light, negatives being obtained in 15 seconds enlarged 1500 diameters. As the chromatic aberration was not corrected, it was found easy to illuminate the object either with white or bluish-white light, use of the red or yellow rays being of course carefully avoided.

The proper distance of the condenser from the object is a point of much importance, and is best ascertained by carefully repeated trials. To obtain really good results much nicety in arranging the illumination is required: this is a matter in which microscopists are well practiced, but to secure the best results possible *under the circumstances*, as in photographing test objects, the art and patience of the operator is taxed to the utmost, and several days are often consumed before a really satisfactory result is attained, even in the case of a single object.

Focal adjustment, &c.—Trouble will be saved by selecting the exact object which is to be photographed, by the microscope in an upright position, the instrument is then inclined and connected with the camera. After the compound body is thus placed, if the objective is provided with a "screw collar" for correction, this adjustment must be *carefully made.* Even when this point has received attention, it by no means follows that the chemical focus coincides with the visual, and the exact correction necessitated by this difference must be ascertained by trial. This can be effected by the use of the fine adjustment, (see Shadbolt's paper). Contrary to some other observers, I have found it necessary when using sunlight, with both high and low powers, with, and without eye-pieces, to make this correction

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carefully. The use of the rod and the lever and achromatic lens has already been mentioned. After the corrected image has been thrown on the ground glass it will remain nearly unaltered from 30 seconds to 10 minutes, according to the power and mode of illumination employed.

Collodion.—This article when furnished by makers of repute can of course be used, though it is better for more than one reason to be independent of the dealers if possible. A considerable number of samples of pyroxyline were prepared according to different receipts and sensitized variously. The very simple process described by Waldack, on page 266 of his treatise on Photography, was found with slight modifications to yield an excellent article.* The strength of the sulphuric acid was slightly greater than recommended by him, no water was added, the temperature also was slightly higher, at the time of the immersion of the cotton: a more prolonged washing than that prescribed in this work is desirable. This collodion can be sensitized with advantage by the iodid and bromid of cadmium in the proportion of four to one. A receipt published in Humphrey's Photographic Journal has lately been used by me with very good results.†

No. 1.	No. 2.
Plain collodion, 1 oz.	Plain collodion, 1 oz.
Iodid of ammonium, 5 grains.	Iodid of potassium, 5 gr.
Bromid of potassium, 3 do.	Bromid of ammonium, 3 gr.

Dissolve the iodid of ammonium and bromid of ammonium in alcohol, the iodid of potassium and bromid of potassium in the least possible quantity of water, before adding them to the plain collodion. Mix Nos. 1 and 2 in equal parts for use.

This collodion when used according to the wet process, though not very intense when first made, is quite sensitive, negatives of landscapes being obtained in $\frac{1}{4}$ of a second indicating by their strength that a shorter time would suffice. It acquires intensity by keeping. The exposure is effected by the flap at F, and will last from $\frac{1}{4}$ of a second to 4 minutes according to circumstances. The development is as usual, hyposulphite of soda being used as a fixing agent. The use of the bromid of arsenic, mentioned in the same Journal, gave with some samples of collodion, excellent results so far as intensity was concerned.

The negatives thus obtained, are examined by a lens of one inch focal length, to test their degree of sharpness. This quality will not only vary with the manipulation, but with the nature of the object; the sharpest negatives obtained by me, when examined by a power of 40 diameters, appear as well defined as finely executed lithographs seen by the naked eye, while other classes of objects, (dots in pine wood, &c.,) with all care, yield

* Treatise on Photography by Chas. Waldack, Cincinnati, 1860.
† Humphrey's Journal, Joseph H. Ladd, New York.

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negatives which present the same appearance under a much lower magnifying power.

Positive prints.—In order to preserve the fine details, the prints should be taken on glass, not on paper; mica answers when a print is to be transmitted by mail. Great care should be used that little or none of the fine markings on the negative are lost in this process; a bright light (sunlight thrown on the negative backed by ground glass,) a small diaphragm before the copying lens, and careful allowance for the chemical focus, are the essentials. To produce enlarged positive prints on glass, the negative is placed on the stage of the microscope and treated like a microscopic object, the magnifying power varying from 5 to 20 diameters. If the prints are to be on *paper*, it will be found that a more liberal use of nitrate of silver and chlorid of gold, than is generally recommended makes success easy.

Magnifying powers employed.—To produce enlarged images the objectives as is well known may be used alone or in connexion with an eye-piece. In the former case with proper illumination, sharp images are produced when the distance between the object (on the stage,) and the ground glass is as great as five feet. With this distance the

1	inch	enlarges	65	diameters.
⅓	"	"	190	"
¼	"	"	460	"

In using the objectives in this way the screw collar is set *after* the microscope is connected with the camera.

For more highly enlarged images it is best to add the long eye-piece as has been practiced by some experimenters. The adjustment of the screw collar can then be very nearly completed before the microscope is connected with the camera, which is a great saving of time, it will of course fall nearer the mark "uncovered" than in the first case. However perfectly this operation may be performed in either instance, allowance must still be made for the actinic focus. By varying the distance between the eye-piece and the ground glass different degrees of enlargement are obtained. When the long, or two inch eye-piece, is used, the distance from the object-slide to the eye *lens* being 12 inches, from the latter to the ground glass 34 inches, then

1	inch	enlarges	160	diameters.
⅓	"	"	550	"
¼	"	"	1300	"

Powers obtained in this way with the two latter objectives have been used by me with advantage.

Thus with the ¼th 113° aperture, the Wollaston doublet of 44° aperture having a central stop, being used as a condenser, I obtained sharp negatives of the *P. angulatum* magnified

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1300 diameters with well defined hexagonal markings similar to those obtained by Whenam with a $\frac{1}{12}$th of 130° aperture. Portions of the negative bore a photographic enlargement of 10 diameters. Mr. Whenam announces* that he has discovered by the use of a $\frac{1}{25}$th of large aperture, made by himself, that the markings on this object and on some others, are really due to spherical particles of quartz which can be made by illumination to appear hexagonal. With a power too low, I obtained photographs of the *P. Balticum* with *hexagonal* markings; with a higher power and larger angle of aperture the tendency was to the spherical form.

Photographs by Polarized light.—A Nicol's prism is placed under the stage, one also directly behind the objective, sunlight is reflected from the mirror, and one of the prisms revolved till the field is dark; with the low powers by this simple arrangement photographs of objects may be obtained, which exhibit the structure revealed by the polarized light. For higher powers it is necessary to use the polarizing arrangement described by von MOHL, *Pogg.*, vol. cviii, p. 178, and recommended by Carpenter; that is, the light from a large Nicol's prism is concentrated on the object by an achromatic condenser. The perfection with which this apparatus operates may be inferred, when I state that photographs of the cross and rings in starch granules as well as of the *P. angulatum* in a dark field, were obtained by me without difficulty. Von Mohl remarks, that with inferior apparatus some very distinguished observers have been unable even *to see* these appearances. The selenite stage can of course be used when it is found desirable.

By arranging the apparatus according to the plan adopted by Prof. v. Kobell in his micro-stauroscope, (this Journal, [2], vol. xix, p. 425), the peculiar effects which microscopic crystals produce on the cross and rings of calc spar, can be photographed. By removing the condenser and objective, as well as the slide containing the crystals, beautiful photographs can be obtained of the normal cross and rings; the systems of rings in other crystals can be photographed by substituting them in place of the calc spar, as well as the changes which they undergo by combination with plates of doubly refracting substances, (circular analysis, &c.,) it being merely necessary to introduce the plates or films at the proper positions. I was shown by Prof. Dove some years ago while in Berlin, photographs of the normal cross and rings around the axis of the calc spar, but so far as I know this is the first attempt to photograph the changes which the cross and rings undergo by the action of microscopic crystals.

Stereoscopic photographs of microscopic objects, can be obtained with the monocular microscope, by covering first the right half of

* Quart. Journal of Mic. Science, No. xxxi, p. 145.

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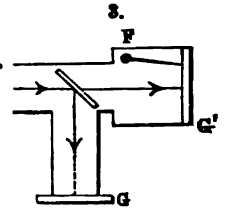
the objective, then the left by a suitable brass cap, and taking two successive pictures. When using this method it becomes necessary to move the mirror towards the right or left hand with each successive exposure, which is not only inconvenient, but often produces a slight distortion, that prevents the proper stereoscopic union of the two photographs. On this account I have generally adopted a different plan; the object is placed on an extra stage, which can be inclined from 5° to 10° as seen in profile in the wood cut, fig. 2; it is photographed first at one angle then at the other. In practice the manipulation is easy, and no particular difficulty is experienced from the fact that the extreme right and left hand portions of the field are thrown slightly out of focus. High and low powers can be used equally well. The second negative should be taken immediately after the first, before the illumination has altered. I do not know that stereographs of microscopic objects have actually been taken by other experimenters, though this may easily be the case.

2.



Living organisms offer the photographer some difficulties by their constant motion about the field, and in and out of the focus. It becomes necessary to adopt a plan by which the image can be thrown on the sensitive plate, the very instant after the animalcule has been brought into focus. The following method has been used by me with success to obviate this particular difficulty: a plate of glass with parallel sides is introduced at an angle of 45° into the tube outside of the camera; it reflects an image of the object to the ground glass at G, fig. 3, which is placed so that an equally sharp image of the same object is formed at G′. The sensitive plate is introduced at G′, the flap at F being closed; with one hand the operator, by the aid of the image at G, focuses on the animalcule, just as this is effected, the plate is exposed by the other hand turning the flap. If the collodion is sensitive, a second, or less, suffices to give an image; if a longer exposure be desired the image of the animalcule on the ground glass at G can be watched, and the exposure prolonged till the creature begins to change its position. The real difficulty, in the case of living organisms, is found in the fact that all parts of them do not lie in the same focus; this in fact is one of the most important difficulties connected with the whole subject of microscopic photography. But the introduction of a slight modification in the ordinary compressorium, removes it in many cases; the plate of glass on which the objects rest, instead of being plane, is made slightly *convex*, by the use of a spectacle lens of rather long focus; objects to be examined are placed near the point of contact, and pressure applied as usual, when they are brought nearly into the same plane.

3.



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Photographs of opaque objects were obtained by concentrating sunlight on the object, either with the concave mirror properly mounted, or with the plane mirror and bulls-eye condenser. The 1½, 1 and ¼ inch objectives were employed. The color of microscopic injections for this purpose should be blue or white, though with a long exposure photographs were obtained of yellow injections.

I am indebted to Dr. Wolcott Gibbs and to G. T. Strong, Esq., for valuable suggestions relating to the subject of this article.

As some interest has lately been manifested with regard to eye-pieces, it may be proper to state, that, in the course of this investigation, three eye-pieces were constructed, No. 1, on the general Huyghenian plan, the eye lens being an under-corrected *achromatic*;* the distance between the eye and field lens could be varied at pleasure, as advised by Amici; as a single microscope its power was eight diameters. The general performance of this eye-piece seemed to me somewhat better than that of the plain Huyghenian eye-pieces with which it was compared.

No. 2 was a Kellner eye-piece, the distance between the lenses could be varied; alone it enlarged 12 diameters. The performance was good. No. 3, consisted of two under-corrected achromatic lenses combined in the Huyghenian manner; alone it magnified 25 diameters. When used as the eye-piece of a telescope it gave a pretty good image; as a microscopic eye-piece, it was inferior to No. 2 in spite of its superior magnifying power, except perhaps when used with well corrected objectives of large angular aperture. With all three eye pieces the correction of the objectives remained unaltered in kind.†

Troy, N. Y., July, 1st, 1861.

Art. XXIII.—*On some questions concerning the Coal Formations of North America.* (Continued from p. 25 of this vol.)

By Leo Lesquereux.

Families, Genera and Species of Fossil Coal Plants in the United States.

This general examination is made for a two-fold purpose. First; to see how the remains of fossil plants found in our American coal-measures agree in characters with those of Europe: or rather to find if these remains of ours cannot give some farther light concerning species, genera and families of coal plants, al-

* The orthoscopic eye-piece of Grunow consists of an eye lens partially achromatized in combination with a field lens differing in form from the ordinary Huyghenian.—O. N. R.

† After this article was in print, I received from a friend a paper of Amasa M. Eaton, Esq. (*Proceedings B. S. N. H.*, vol, viii, p. 105.) Mr. Eaton has devoted himself with success to the production of *ambrotypes* of microscopic objects.

Troy, N. Y., July 23d, 1861. O. N. R.

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ready known from European researches. The fossil flora is very similar to the history of olden times. It is known only by fragments and these must be connected by links and repeatedly elucidated by corresponding data, collected from the monuments of various nations.

Second; to present a comprehensive review of the main facts known up to the present time about our coal flora and to establish, by a critical comparison, the essential characters of the families, genera, and even some species of our coal plants.

§ 1. *Fucoides*, Brgt.

Under this name, a number of vegetable remains of the coal have been formerly described and referred to marine plants. Indeed some geologists have applied the term *Fucoides* to every one of those uncertain forms, mostly stems and roots, which could not be referred to some species known and published before. The *Fucoides* are not only very rare in the true coal measures, but I even doubt if a single specimen of a true marine plant has ever been found in these measures. At least I have seen none, and all the numerous specimens sent to me under that name were incomplete fragments, either of stems or of roots, of some true coal plants.* Mr. Brongniart had already remarked that all the vegetable filaments considered as *Confervites*, like those published by Artis under the name of *Hydatica* and *Myriophyllites*, were roots. Mr. Unger in his classification of fossil plants according to geological formations, (*Genera and species*, page 533), quotes among *Fucoides* of the coal: 1st. *Chondrites Prestvici* (Mor. cat.) an undescribed and unknown species, whose locality is not even mentioned. 2d. *Chondrites dissimilis* (Eichw.) from the mountains of Donetzky in Russia. It is published by Eichwald in the Urw. Russia, p. 89, t. 3, fig. 3, but rather resembles a *Hymenophyllites* than a Fucoid. 3. *Chondrites trichomanoides* Göpp., *Systema foss.*, t. 30, fig. 26, a plant formerly described by the author as a *Trichomanites* and which appears to belong to that section of Hymenophyllites which I have called *Pachyphyllum* (Penn. Report). This plant was found in a kind of shale called by Mr. Göppert *stinkende* with remains of fishes. 4 and 5. *Fucoides Alleghaniensis* (Harl.) and *Fucoides Brongniarti* (Harl.), both belonging to the Silurian or Medina sandstone of our country. 6. *Rhodomelites bijugus* (Eichw.) from the mountains of Russia with *Fucoides subtilis* and *Fucoides tæniola* of the same author. These two last species are not described. Though Eichwald is a very good observer, we can but suppose: either that his four species of fucoides are fragments of coal plants, or that the for-

* We cannot call them either marine or fresh water plants. The coal plants as remarked before, had a peculiar nature, like those of the peat bogs and were appropriated to the formation of the coal. They could vegetate with slight modification of forms either in or out of water and probably both in marine and fresh water.

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mation where they have been found is not within the true coal formations. In his *Tableau des Genres*, Mr. Brongniart mentions as pertaining to the *Carboniferous period* two *Chondrites* and two *Amansites*. These last two are *A. serra* and *A. dentata* belonging to the Silurian of Canada; the two others also pertain to the transition formations inferior to the Devonian.

I could easily refer to *Fucoides* a number of specimens undeterminable, branches or stems that look like marine plants. I have especially a smooth, flexuous, linear, apparently rounded branch about the fifth of an inch broad, perfectly equal in its whole length, resembling a piece of *Corda filum* or of *Zostera marina*, found in the shales of the upper strata of the Kentucky coal measures with remains of fishes and of marine shells. But describing such remains and referring them to marine plants would be only an hazardous hypothesis. The stems and leaves of some plants of the coal of Pomeroy are covered with a brownish, thick epidermis resembling the thick leaves of some *Fucaceæ*. But this kind of skin is mixed with remains of ferns and cannot be referred to *Fucoides* without a better proof than this leathery appearance. Prof. Geinitz does not mention any *Fucoides* in his fossil flora of Saxony.

2. *Fungineæ* (*Mushrooms*).

As far as the evidence of fossil plants can be trusted, it seems to prove that species of the mushroom family were living during the period of the formation of the coal. It is especially some of those small, mostly round species of the *Hypoxyleæ* tribe, that have been found attached to leaves and stems of fossil ferns. One of them is described by Prof. Göppert (Syst., p. 262, t. 36, fig. 4), with the name of *Excipulites Neesii* on the leaves of *Hymenophyllites Lobelii*. The same is described again by Geinitz (*Verst.* p. 3, pl. 23, fig. 13,) on the leaves of *Sphenopteris tridactilites*. In this last author we have also, belonging to the same tribe, a *Depaxites Rabenhorsti* and especially the *Gyromices Ammonis*, Göpp. This last species is the only one that has been found heretofore in our Coal measures of America and that I have been able to examine. It abounds on the leaves, the stems and even the naked substance of the shales overlying the coal (No. 3) at Colchester, Illinois. I have seen it also on a piece of fossil stem from Carbondale, Penn. (Specimen No. 711 of Amherst College). It was first named by Göppert, then described and figured by Germar (*Verst.* fasc. 8, p. 112, tab. 39, fig. 169) and more recently by Geinitz. It is a small spiral body about the tenth of an inch in diameter, with the spires progressively enlarging and greatly resembling our *Planorbis parvus* (Say) a small shell now living in fresh water under the leaves and on the stems of floating plants. Its outer end, which in the figures of European authors is blunt and obtuse, appears, on our specimens,

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abruptly cut and hollow, like the mouth of a thick shelled mollusc. It is finely striated across; and under a strong lens looks like a beautiful small *Ammonites*. From numerous cross sections of good specimens of this small body, I must admit, contrary to the opinions of the learned European authors who have studied it, that it is a true shell, most probably a species of freshwater mollusc. Internally it is hollow, with a hard, thick, parietal substance, generally of lighter color than the shale. It is true that it is often found within the carbonaceous matter of the leaves and of the stems, and thus would appear to have lived within the substance or under the epidermis of the plants like some *Hypoxyleæ*. But at Colchester, at least, it is still oftener found within the naked substance of the shales. Moreover if it was a shell living on the stems and leaves of the coal, it has been of course imbedded by compression as well in the softened woody and carbonaceous matter of the plants as in the soft clay. Germar has already remarked that he found it on shales, without any apparent connection with vegetable substance. But he supposes the possibility of the destruction of all vegetable substance, except that of this small fungus; a supposition which appears somewhat extraordinary. The presence of fresh water shells in the bogs of the coal can not be doubted after the remarkable discovery by Prof. Dawson of a fresh water *Pupa* in the coal fields of Nova Scotia.* And the scarcity of these molluscans in the coal measures is in accordance with what we see on the peat bogs of our time, where the number of fresh water shells is extremely limited. I can not but say again how difficult and hazardous it is to determine such small bodies attached to petrified stems and leaves, from the impossibility of examining their internal structure and of finding the spores. External and variable forms exactly like small fungi are often mere unorganized bodies, produced by some mechanical or chemical action. All the remains of plants and even the shales overlying the semi-anthracite coal of Trevorton, Penn., are covered with small round vesicles, of different sizes, looking exactly like *Spheriæ*, and are filled with a brown powder resembling spores. Sometimes the coal itself is full of them. They have probably been formed by the ebullition of the whole matter accidentally stopped during a strong gaseous emission.

Another very remarkable fungus, *Polyporites Bowmanni*, is described by Lindley and Hutton in the fossil flora of Great Britain, (vol. i, No. 65). This species, or at least one, agreeing exactly with the figure and description of the English authors, was found in black bituminous shales overlying No. 1B coal at Johnstown, Penn. It is an hemispherical or reniform body, marked with concentrical zones, especially distinct near and

* Proceedings of the Geological Society of London, (Dec. 14, 1859).

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along the margin. As Prof. Lindley remarked it: "it is like one of those fungi belonging to the genera *Boletus, Polyporus, Thelephora, Dædalea*, &c., (our species rather resembles a zoned *Boletus*), which attach themselves to their support by one side, projecting forward from it and increasing by periodical additions to their margin, in consequence of which that part assumes a zoned appearance." The lower part of these Fungi, the *Hymenium*, is a more or less thick compound of vertical, cylindrical or angular pipes or tubes closely united together and containing the seeds. It separates more or less easily from the upper part or the hat of the Fungus. Our American specimen is more perfect or better preserved than the two which have been found in England. Two-thirds of the surface show the disposition of the zones of what I consider to be the lower part of the hat or *Pileus*. The balance of the surface, just in the middle of the specimen, is occupied by what appears to be a piece of the undetached *Hymenium*. This part, which is concentrical and exactly in concordance with the zones, is even evidently zoned though less visibly than the *Pileus*, and formed of square, radiate and concentrical areolæ, running around a central point and from it to the margin. This confirmation can not be compared to that of a scale of fish. It is exactly that of a compressed and petrified *Boletus*. The celebrated English author was only prevented from giving the same decided opinion by the mark, on the surface of specimens, of some lines *which are not in accordance with the radial lines near the margin*. This appearance is probably caused by the superposition and agglutination of some piece of another plant. The American specimen has nothing like it and it removes the only objection made against the admission of this species as a true Fungus or mushroom. The black bituminous laminated shales where it was found contain together with it abundant remains of *Lepidodendron*, especially of its leaves and cones.

2. *Lichens, Mosses and Liverworts.*

Brongniart and other palæontologists have already remarked as a peculiar phenomenon, the absence of every trace of fossil Lichens, Mosses and Liverworts in the old formation of our earth. A few mosses and Hepaticæ only have been observed in formations no older than the tertiary,* and especially in pieces of amber in Germany.†

Many years ago, I found around Pottsville, Penn., a kind of laminated soft gray shales, splitting in thin lamellæ and resem-

* Heer's Flora tertiary Helvetica and also Ungers' Genera; Dunker's Monegr.; and Brongniart's fossil flora.

† H. R. Göppert and G. C. Berendt, die in Bernstein befindlichen organischen Reste der Vorwelt.—Göppert in Berichte der Berlinen Academy, 1853.—Menge Beitraege zur Benstein flora in den Schriften der Nat. Gesell., zu Danzig. Bd. 6, H. 1.

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bling pasteboard, whose surface bears the traces of the remains of very small, innumerable fragments of thin filaments, mixed with an indistinct compound of what appears to be very small detached oval leaflets. At first, I compared them to, and found them to resemble those indistinct forms of leaves and stems, which are seen on the surface of the pieces of peat, when this matter has been formed by the Sphagnaceæ, a tribe of the Mosses. I have come again and again to the examination of those peculiar shales, expecting to find some distinct outline of the plants which cover them with their remains. But nothing more can be seen than what I had discovered at first, and this is not enough to authorize the conclusion that these remains are those of certain mosses.

4. *Filices*, (*Ferns*).

The following remark of Mr. Brongniart in his *Tableau des genres*, (p. 15) is fully confirmed by the examination of all the specimens of fossil-ferns that I have been able to collect from our coal measures. He says: "*that he is satisfied that in the classification of fossil ferns, we must establish genera from the attentive study of the nervation and of its relation with the general form of the pinnules and of the fronds. That we can not look for reliable characters to the fructification, until it has been possible to observe the sporanges or fruit-dots of the great majority of the species*," &c. The number of fruiting species of fossil ferns, found in the coal measures of the United States, is already great indeed. But I have not been able to observe in a single case anything else about the fructification, except the position of the spores relatively to the nerves. And this, even, seldom. The true characters used for the classification of the living ferns, viz., the form of the fruit-dots, their mode of attachment and their involucre or *Indusium* could not be ascertained in a single case. Among the most remarkable and distinct fruiting specimens of ferns, I have got two at least, and perhaps three, which show the sporanges separated from the leaves, appearing to be born on separate pedicels, as it happens in many species of our time. One is *Staphylopteris stellata* Lsqx.,* from the sub-conglomerate coal of Arkansas. Another, undescribed represents small bunches of round, flattened sporanges, somewhat inflated on the margins, and attached on a bipinnately divided branch, on both sides of a common narrow rachis, resembling the medial nerve of a *Pecopteris*. The whole bears some resemblance to a fruiting branch of our common *Botrychium Virginicum*. It might be supposed from the disposition of the sporanges, which is like that of *Asterocarpus Sternbergii*, Göpp., that the substance of the

* Second vol. of the Geol. report of the State Survey of Arkansas.

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leaflets supporting them has been destroyed by maceration; but there is no trace of any such substance and the sporanges are at some place irregularly distributed. A third species, also undescribed, represents a few narrow leaflets, the upper part of a pinna, with very strong, arched, dichotomous, reticulated nerves, marked, in relief on the stone, appearing like the supports of sporanges destroyed by maceration. I consider it as the remains of the fruiting branch of a *Neuropteris*. But all these fruiting branches can not be referred except by mere supposition to species of fossil ferns known by their leaves and classed by their nervation. They must be described separately as fruit and their relation to peculiar species of ferns can not be mentioned, till they are found in connection with their leaves.

Of course this can not change the views expressed above, concerning the classification of the fossil ferns, but only force the admission of one or more of those artificial and unreliable genera, which may be eliminated by the discovery of better specimens and with which fossil botany has to be satisfied for the present.

With the exception of a few species which can be separately classed as species of doubtful affinity, all our fossil ferns may be contained in the three following tribes: 1st, *Neuropterideæ*, 2d, *Pecopterideæ*, 3d, *Sphenopterideæ*. The great Palæontologist Göppert, in reviewing in his *Genera* (liv. 3 and 4, p. 48), a former classification of his *Systema*, has admitted two other tribes, the *Danaeaceæ* and the *Gleicheniaceæ*. But we have not thus far in our coal measures any representative of the first; and our species of the second, like *Gleichenites artemiscæfolius* Göpp., (*Sphenopteris* Brgt.,) belong by their nervation to the *Sphenopterideæ*. Both these divisions may thus be left aside for the present.

1st Tribe. *Neuropterideæ*.

The classification of our American species seems to necessitate a slight modification in the subdivision of this tribe admitted by the European author. I would subdivide it in the following genera: 1st, *Noeggerathia* Sternb., 2d, *Cyclopteris* Brgt., 3d, *Neuropteris* Brgt., 4th, *Odontopteris* Brgt., and 5th, *Dicthyopteris* Gutb.

1st, *Noeggerathia* Sternb. This genus was first established by Sternberg, *Vers.* p. 28 for the description of the figure of its plate 20th; then by a more appropriate description page 33, and definitively page 36th of his 4th book where he limits as follows the genus *of uncertain affinity: Caudex ignotus; rami teretes, pennam anserinam æquantes, lignescentes; folia alterna, approximata, obovata, ramum basi semi-amplexantia, apice pectinato-dentata, integerrima.* The author does not mention the nervation, but his description is completed and somewhat modified by Mr. Göppert

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who in his Genera (liv. 5 and 6, p. 107), has described another specimen of Sternberg's species, *Noeggerathia foliosa:* and fixed the genus thus: *Frondes petiolatæ, pinnatæ; pinnæ obovato-cuneiformes vel obovatæ, lateribus petioli applicitis semi-amplexicaules, nervis numerosis teneribus, plerumque simplicibus ab ima basi adscendentibus percursæ.** Göppert then describes two new species of this genus: *N. obliqua* and *N. Beinertiana.* The figure of both represent only part of much longer leaves than those of Sternberg's species. These leaves lacerated on one side have an appearance far different from that of the Ferns, to which nevertheless Mr. Göppert refers this genus. Brongniart, in his *Tableau des genres* has described again this *Noeggerathia foliosa* and from the simple pinnate form of the frond, the rigidity of the leaflets and the mode of nervation, he compares it to a palm or rather to the American *Zamiæ.* He has thus made a separate family of the *Noeggerathiæ*, and places it between the *Cicadeæ* and the *Coniferæ.* This Family contains only two Genera: *Noeggerathia* and *Pychnophyllum*,† this last one replacing the *Flabellaria* of Sternberg or rather including only *Flabellaria borassifolia* Sternb. Mr. Geinitz in the *Versteinerungen*, &c., has apparently admitted Brongniart's views. He places the family of the *Noeggerathiæ* with the Dicotyledonous plants having the same two Genera and refers to *Noeggerathia* a number of fossil fruits of the Genus *Rhabdocarpos.* This variety of opinion and uncertainty of the characters of both the genera *Noeggerathia* and *Cordaites*, is perplexing indeed. But I think that the examination of our American specimens, referred to these Genera may help to fix their true characters and place.

It is evident that both the species published in the report of the State Geological Survey of Pennsylvania as *Noeggerathia minor* and *N. obtusa*, are true *Noeggerathia*, according to the description and the figure of Sternberg's species. They correspond not only with Sternberg's and Göppert's description of the genus, but with the remark of Brongniart about the nervation and the rigidity of the leaves. The branch figured on plate 1 fig. 10, shows that these plants were at least bipinnately divided. Since the publication of this report I have had opportunities to examine better specimens of the same species and especially have lately received from Prof. J. D. Dana of New Haven, the figure of a splendid specimen of *Noeggerathia obtusa*, found in the old Red Sandstone of Montrose, Penn., by Rev.

* The restriction *plerumque simplicibus* can not be admitted for such leaves as those of *Noeggerathia foliosa* when the nerves all come from the base. They must of course much divide in ascending.

† This genus is wrongly ascribed to Göppert by Geinitz in his *Versteinerungen*, &c., p. 40. In the *Tableau des genres*, by Mr. Brongniart (published in 1849), the author establishes the genus *Pychnophyllum* for replacing *Flabellaria.* Mr. Göppert admitted it only in 1852. Brongniart's genus has even the priority over *Cordaites* proposed by Unger in 1850. But this last name should be preserved as a well merited compliment to Corda who has so admirably described and figured the *Flabellaria borassifolia* (Sternb.).

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Henry A. Riley. It shows the upper part of a frond with three oblique pinnæ somewhat reflexed from their base and the pinnules or leaves, broadly oval or reniform, the upper one flabellate, all narrowed to the base and pinnately attached on both sides of the rachis by a narrow decurring base. The point of attachment of the leaves is just as I have figured it in my report. This splendid specimen has evidently the general outline and the appearance of a fern and at once puts aside Brongniart's surmise that the simply pinnate form of the leaf, &c., show it to be analogous to the *Zamiæ*.

On the other side, I have been able to find in the Anthracite basin of Pottsville, a stem of *Cordaites* with some of the leaves attached to it. It agrees exactly with the one figured by Corda though less well preserved and entire. It is a simple stem, about half an inch thick, bearing numerous long, ribbon-like, clasping leaves, spirally placed around it, marked with sharp, narrow, parallel, mostly simple nerves. The leaves are scarcely narrowed at the base and thus nearly linear; but, as I have seen it many times and as Corda's figure shows it, the leaves near the top of the stem become shorter somewhat narrowed at the base, spathulate-oblong, just of the same form as both the leaves of *Noeggerathia obliqua* and *Noeggerathia Beinertiana* figured in Göppert's Genera. I will not say that Göppert's species are not true species or belong to the same *Cordaites* as ours; but I believe that all those broken leaves described by Göppert as *Noeggerathia* ought to be referred to the genus *Cordaites* and removed from the Fern-family. I think that the genus *Noeggerathia* should be characterized as follows: *Frond bipinnately divided. Pinnæ, long, linear, oblique, flexuous; pinnules alternately and pinnately placed on both sides of the rachis, enlarged above, obovate, obcordate or reniform triangular, narrowed at the base and obliquely attached to the rachis by a narrow sometimes slightly decurrent base. Nerves equal, numerous, emerging from the base and forking in ascending.* To this genus thus limited I would refer *Noeggerathia foliosa* Sternb., *N. minor* Lsqx., *N. obtusa* Lsqx., *N. flabellata?* Ll. and Hutt., *N. Bockschiana* Lsqx., *Cyclopteris dissecta* Göpp., *C. hybernica*, *C. McCoyana? C. Jacksoni* Daws., with some other *Cyclopteris* with a narrow angular base and even perhaps *Odontopteris imbricata* Göpp. If we except of these species *Noeggerathia flabellata* and *N. foliosa* both of the lower coal, the first of England, the second of Bohemia, all the other species pertain to the Old Red Sandstone and thus the botanical classification very well agrees with the geological distribution. For this reason, especially, I doubt if *Noeggerathia cuneifolia* Brgt., of the Permian of Russia belongs to this genus, or it may be, as I have remarked it formerly, that, as this species is found with a *Lepidodendron*, its geological horizon has not been exactly marked.

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To the genus *Cordaites* thus characterized: *stem simple, annulate or marked by the persistent base of the leaves; leaves simple, clasping at the base, long-linear, marked by simple, equal, parallel, rarely forking nerves:*—I would refer all those ribbon-like leaves so abundant in our coal measures, and generally found in broken fragments. *Noeggerathia palmæformis* Gopp., recently found in the coal fields of Illinois, *N. Beinertiana* Gopp., *N. ovata*, *N. abscissa*, *N. dichotoma*, *N. tenuistriata*, *N. Bruckeriana*, *N. crassa*, all species of the same author are referable to *Cordaites*. At least as much as can be seen from the figures that mostly represent fragments of leaves.*

2. *Cyclopteris* Brgt. By somewhat extending the definition of the genus *Cyclopteris*, it would be easy to place in it most of the species, if not all, of the genus *Noeggerathia*. But the name of this last genus has the priority to that of the former, and moreover the fine descriptive name, *Cyclopteris*, represents a kind of leaves far different from those to which Sternberg applied the name of *Noeggerathia*.† At first, it contained a number of species established for isolated round leaflets which a more careful observation showed to belong to species of *Neuropteris*. As the relation of species of *Cyclopteris* to species of *Neuropteris* is not easily ascertained, Brongniart made for these doubtful forms a new genus with the name of *Nephropteris*. Numerous American specimens have furnished satisfactory evidence of the identity of most of the species of *Nephropteris* with some species of *Neuropteris* and *Odontopteris*. They are mostly large, round leaflets, placed at the base of the primary pinnæ at the point of union with the common rachis or sometimes pinnules or leaves of an abnormal form, placed on the common rachis between the primary pinnæ or even on the pinnæ, between leaves of a normal form. We can thus eliminate the genus *Nephropteris* and refer to *Neuropteris* the species formerly belonging to it. I can scarcely refer any American species to the genus *Cyclopteris*, as it has been limited by Brongniart in his *Tableau des Genres: frond simple, pedicellate, symmetrical, round, cordiform* or *flabellate, entire* or *lobed, without traces of medial nerve, all the nerves coming out from the basis of the leaf and diverging in dividing or forking to the border.* I have found only a small incomplete specimen of *Cyclopteris flabellata* Brgt. It is no longer in my possession and I am unable to say if it represents exactly the European species. I know nothing more of it but what is said on p. 855 of the Report of the Pennsylvania survey.

3. *Neuropteris* Brgt. The celebrated Göppert had in his *Systema* admitted a new genus, *Adiantites* for a number of these

* Prof J. W. Dawson has adopted the same views in a paper recently published in the Canadian Naturalist.

† Jac. Nöggerath to whom the genus is dedicated is author of valuable researches on fossil trees and stems published at Bonn, 1820–21.

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species intermediate between *Cyclopteris* and *Neuropteris*. But in his *Genera*, liv. 5 and 6, p. 90, he puts the classification aside and admits Brongniart's genus *Cyclopteris* with some modification, so as to place in it a number of species which I consider true species of *Neuropteris*. Indeed, the essential character separating his genus *Cyclopteris* from *Neuropteris* is, for the former, the nerves emerging from the base of the leaves and flabellately diverging and dichotomous in ascending; while in the genus *Neuropteris*, the medial nerve is marked from base up to above the middle of the leaves and disappears near the summit. Now, it is certain that a number of our *Neuropteris* have for the same species the two kinds of nervation that characterizes Göppert's genera. In *Neuropteris hirsuta* Lsqx., the long leaves are generally strongly nerved up to the middle; while the round leaflets, attached at their base, as also the upper leaves of the penæ, which become simple, have all their nerves flabellate from the base without a trace of a middle nerve. *Neuropteris Clarksoni* Lsqx., bears on the same pinnæ two kinds of leaves, the one longer, narrower and strongly nerved in the middle; the others shorter, broader, with all the nerve flabellate from the base. This *Neuropteris* appears to be the American representative of *Neuropteris auriculata* of Europe, essentially differing from it by the strong medial nerve that marks some of its leaves. In *Neuropteris Loschii* Brgt. so common in our coal-fields, the medial nerve appears only with the larger leaves of the inferior secondary pinnæ. In *Neuropteris Desorii* Lsqx., again, the leaves attached to the primary pinnæ are marked with a strong medial nerve, ascending nearly to the point, while a number of leaves, attached on the primary rachis, have not only all their nerves flabellate from the base, but are enlarged in outline and take the form of *Cyclopteris*. All our species of *Neuropteris* show the same variety of nervation. Accordingly, I think that it would be more convenient and rational at the same time, to fix the genus *Neuropteris* as follows: *Frond pinnately, bi- or tri-pinnately divided; pinnules or leaves of various forms, round, oblong, oval, mostly entire, sometimes lobed, cut or fringed, attached to the rachis only by the middle point of their base. Medial nerve sometimes distinct and vanishing above; secondary nerves numerous, either obliquely emerging from the medial nerve or flabellate from the base, all arched and dichotomous.**

4. *Odontopteris*. The only essential character which separates this genus from the former is that in *Odontopteris* the pinnules or leaves though separated from each other, are attached to the rachis by their whole base or by the greater part of it. The nervation is very variable; the nerves either running from the whole base and straight as in *Odontopteris Schlotheimii*, or emerging

* As the genus is here limited, both the species *Neuropteris Moorii* Lsqx., and *Neuropteris Adiantites* Lsqx., ought to be separated from it and placed elsewhere.

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from an enlarged base, flabellate, dichotomous, and arched as in the larger leaves of *Odontopteris Alpina*, Sternb. This last species, a beautiful one, has been lately found in the Anthracite coal measures of Rhode Island,* together with a number of our common coal plants, mostly the species characteristic of No. 3d and No. 4th coal. Our specimens are far more complete than any of those published in Europe. The frond, tripinnately divided has the primary pinnæ very obliquely separating from the common broad, narrowly and equally striated rachis. The secondary pinnæ are alternate and open or perpendicular to the rachis. The leaves or pinnules of the lower pinnæ are distinct, somewhat distant, oblong, obtuse, slightly scythe-shaped outward, one to two inches long, attached to the rachis by two-thirds of the rounded base. In the upper part of the frond, the secondary pinnæ are shorter and their leaves or pinnules are also much shorter, reniform or ovate, sometimes united together by the decurrent base, the terminal pinnule is very long, oval-lanceolate, obtuse. Generally the pinnules are shorter on the upper side of the pinnæ, a character already slightly marked in Sternberg's figure. The leaves of the lower pinnæ have exactly the nervation of the genus *Cyclopteris* of Göppert or of the *Neuropteris* with flabellate nervation. On the upper pinnæ, the leaflets even in the same pinna have either a flabellate nervation from the middle of the base, or more generally the nerves emerge from the rachis along the whole base of the leaflets, thus showing that the species is a true *Odontopteris*, as Geinitz has remarked it.

Large specimens of *Odontopteris Schlotheimii* Brgt., obtained from our coal-measures, show that this species found only in fragments in Europe, is tripinnately divided. The primary pinnæ about one foot long are lanceolate, half open; the secondary ones are linear, pinnately lobed with the lobes round or oval, united together near the base or distinct. In this species as in the upper pinnæ of *Odontopteris Alpina*, the first leaflets near the point of attachment of the rachis are generally distinct and their nerves run out from a point in the middle of the base of the leaflet and not along the whole base as in the other divisions.

Another fine and remarkable species of *Odontopteris* was also found recently in connection with No. 1B at Murphysboro, Ill. It is *Odontopteris heterophylla* Lsqx., (in MSS. report of the Geol. State survey of Illinois, pl. 2, fig. 2 to 5). The frond appears bipinnately divided. Pinnæ lanceolate in outline or cordate-ovate. Pinnules or leaves, either entire, obovate-obtuse decurrent on the rachis, becoming broader, shorter, cuneiform-oval near the base of the pinnæ; or elongated, diversely lobed, with unequal, linear-long, or short-lanceolate-oval divisions; terminal

* I am indebted for the communication of a fine specimen of it to Mr. James H. Clark of Newport, R. I.

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pinnule large, deltoid, obtuse, alternately lobed on each side. Nerves sharply marked, inflated near the base two or three times forked; in the decurrent leaflets, the nerves are also a little decurrent along the rachis; in the other leaflets they run out from the whole base.

5. *Dictyopteris* Gutb.—This genus so well characterized by its nervation has still but one representative species, abundantly found in the whole extent of our coalfields, *Dictyopteris obliqua* Bunb. The form of the leaves is variable like their size. The upper pennæ are only pinnately lobed and the lobes separated to the middle, and short and nearly round.

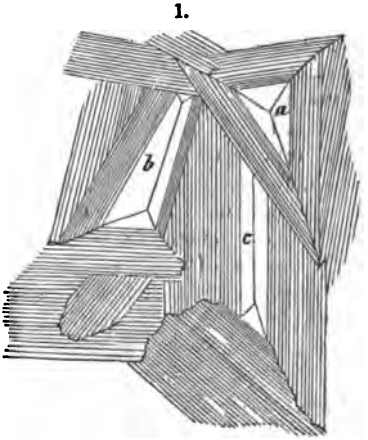
Columbus, Ohio, July 4, 1861.

(To be continued.)

ART. XXIV.—*Observations upon the Freezing of Water at the Passaic Chemical Works, Newark, N. J.;* by ARTEMAS BIGELOW.

ONE of the furnaces having been stopped in the early part of the month of Jan., 1860, the cistern for cooling acid before it is bottled, became frozen on its surface about two inches deep. The cistern was within the building and near the side of it. The weather but moderately cold. On the side farthest from the building the water had oozed up through and overspread the surface, slowly freezing at the same time. Attracted by the appearance of this portion of the ice, I examined, and found it composed of plates or laminæ lying one against the other obliquely to the surface of the water. The masses of plates were also at various angles to each other, leaving many open spaces of regular forms, *a*,*b*,*c*, fig. 1, whose faces were beautifully smooth and perfect, meeting below from their obliquity. The origin of each mass of plates being independent of the others, and extending from below obliquely upwards in three or four different directions, a cavity would consequently be left between the divergent masses, (fig. 1). These laminæ were free, except below, so that a knife thrust underneath lifted them out separately. Also as often as the thumb was applied with pressure to their upper edges, the lines would disappear and the ice at the place of pressure look solid,

1.



a, *b*, *c*, are cavities, the inclined sides meeting at the bottom.

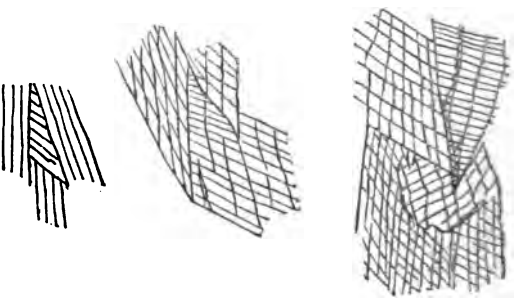
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while moisture oozed out on the surface; but, on the instant of its removal the plates regained their appearance and position; showing that there were intervening spaces filled with water. The extent of surface was about two square feet.

Directing the water to be drawn off, I left it till the next morning, when, the cold having increased, the ice was found solid and transparent, the lines obliterated and the cavities remaining. The next day was warmer, the ice began to melt, and the plates were again apparent, less perfect than before but defined and so loose as to crush under the least pressure. Wherever it was still firm, pieces often a square inch in extent, broken off, frequently showed a brilliant iridescence. The iridescence was in the structure and appeared to be from the surface of a plate not in the same plane with the series adjoining it. When seen edgewise it presented a well defined line like a fine crack, but no separation could be made by a knife any more in that than in any other direction.

A few days after, I found the water in the urn on the top of the office stove frozen except a central cavity. A fire had been made and the ice began to melt. On the top, at the centre, the plates were visible, but imperfect from the melting. Taking out the mass and holding it up to the light, the inner surface was beautifully marked throughout with strong lines at similar angles to each other as existed in the plates above first mentioned, but crossed by finer lines invariably at an acute angle, forming rhombs whose angles were slightly rounded. Fig. 2.

2.



I looked daily for these appearances, as I passed back and forth, for nearly a mile, between the canal and the river, and frequently during the mild weather of the succeeding winter months observed the facts mentioned in the first case, with this difference, that when the cavities were apparent in thin ice formed as usual on the surface of the water, the sides diverged downward, being the reverse, in position, of those mentioned in case first. When water freezes rapidly, the originating centres must be many, the series of plates of small extent, the cavities filled up, a homogeneous mass formed, and no sign of its structure apparent until the slow thawing of spring reveals it, as we shall soon show.

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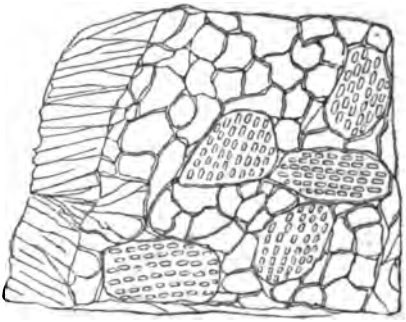
Again, one morning in February, stepping down to the edge of the river I noticed glistening particles of ice upon chips and sticks in great abundance, which proved, on examination with a magnifier, to be hexagonal hopper-formed bodies upon small icy pedestals. The diameter across the top of the hexagon was about one line. The form was very perfect and beautiful, with fine lines running around as if they were the divisions of the crystalline layers, as is shown in the accompanying magnified drawing. Fig. 3.

3.



During the month of February, masses of ice were piled up along the shore above the reach of the tide, and after exposure to the warm sun of that month, lost their vitreous transparency and became nearly snowy white. Their surface was divided up into irregular or oval forms separated by grooves, and lines ran through their thickness, like the joinings of a compact mass of irregular crystals. When a large mass was thrown or let fell upon another mass of ice it broke easily into innumerable crystals. These crystals are irregular and can be called such only to distinguish their general appearance, but almost uniformly show the obliquity mentioned above.

4.



One such mass, fig. 4, had in the large divisions on its surface, oval spots, separated by depressions due to more rapid melting in the joinings. They struck me as parallel to the second case mentioned above, except in this case the angles are completely rounded off by melting.

The noticeable points in these facts seem to be, 1. That water in freezing, under favorable conditions of temperature, forms plates containing between them thin layers of water. Why these water layers do not freeze at such temperature I am unable to tell, unless the air bubbles of the parts crystallized are driven into the intervening spaces and there confined, preventing the water layers from losing heat so rapidly. Whatever be the reason of its higher temperature, the same cause enables those layers when frozen, to melt more easily than the plates, even to the depth of many inches. If the idea be correct that the water layers contain numerous minute air bubbles, then the sun light in passing through the ice, must give up accumulating heat to these bubbles, like the sun shining into an air-tight glass globe. But whatever the cause, this method of freezing and thawing accounts for the manner in which the ice of the great

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lakes and other large bodies of water breaks up in the spring. The presumption is that all ice forming on water is produced in the same manner. But at a very low temperature, the crystallizing centres are so many and the freezing of the plates and intervening spaces so rapid, that the process could not be distinguished. Yet all field ice from this latitude to the arctic regions breaks up in the same manner, by first becoming porous or "rotten." I would ask, can the snows of the glaciers when turning to ice, go through such a process of crystallizing, and can it have anything to do with its supposed plasticity?

2d. The uniform obliquity of its plates, the rhombic markings in case 2d, and the oval spots in the last case indicate a rhombohedral form in the ultimate crystals.

Whether observations similar to these have been made by others I do not know, but they interested me and led me to make the accompanying drawings, and also stereoscopic pictures of some ice masses which had lain exposed for many days to the action of warm sun light. I had intended to renew these observations last winter, but circumstances prevented me from doing so.

ART. XXV.—*Note on the probable Age of the White Limestone, at Sussex and Franklin Zinc Mines, New Jersey.* In a letter to Profs. J. D. DANA and BENJ. SILLIMAN, Jr.; by GEORGE H. COOKE, Prof. of Chemistry, &c., New Brunswick, N. J.

Dear Sirs,—At our late visit to Franklin Furnace, Sussex Co., N. J., I had the pleasure of pointing out to you, the faithfulness of Vanuxem and Keating's original description of the geological occurrence of the rocks of that locality; and the correctness of their conclusion, that the white and blue limestones found there, are of different ages. Since their description was written it has been asserted that the white limestone is of the same age as the blue limestone, though changed in appearance by metamorphic action.

Being confident that the facts cited prove the correctness of the former conclusion and the consequent incorrectness of the latter, I quote portions of the paper which bear upon the above points.

The original article is published in the Journal of the Academy of Natural Sciences, Philadelphia, vol. ii, p. 277, and is entitled, "On the Geology and Mineralogy of Franklin, in Sussex Co., N. J., by L. Vanuxem and Wm. H. Keating." They say, "The whole country to a great distance is composed of what may be considered as sienite. . . . The sienite of Franklin is found in beds or layers of variable thickness, running in a direction parallel to that of the ridge from the N.E. to the S.W. . . . The

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layers or beds incline to the S.E., dipping under at an angle of about 80°. Subordinate to this sienite are found limestone, gneiss, and greenstone. . . . The limestone forms a bed without any apparent parallel seams or divisions, and is peculiarly characterized by its eminently crystallized structure, consisting of large straight lamellar masses, confusedly aggregated. . . . It is of a fine white color, presenting in some instances, a pearly lustre, slightly chatoyant. . . . The direction, inclination and dip of this limestone are the same as those of the aforementioned sienite.

"Next to the sienite, but evidently of a later formation, is found a mass of grauwacke of no great thickness. This grauwacke is generally fine grained, of a light gray color; the fragments, as well as the cement which connects them, appear to belong to quartz. It is found on the north side of the ridge in thin beds or layers, directed from the N.E. to the S.W. and dipping to the N.W.; this grauwacke is evidently of posterior formation to the sienite, and must have been formed after the surface of this rock had undergone those changes which we at present observe in it; for instead of presenting a parallel stratification, it is found inclining in a diametrically opposite direction, and covering the edges or crest of the layers of sienite. The grauwacke and its mode of superposition can be well observed on the road from Franklin to Dr. Fowler's (house) at about a quarter of a mile below the furnace; it is covered by a blue limestone which rests upon it in parallel superposition; this limestone is found in layers or beds of variable thickness; its color is a pale gray sometimes of a deeper gray passing into blue; its texture is compact or subsaccharoidal; near the grauwacke it is slaty."

A locality, where the meeting of the two rocks is plainly exposed, is on the left of the road passing from the tavern at Franklin Furnace to Col. Fowler's and but a few rods from the former place. The gneiss will be seen dipping at an angle of 75° to the S.E. and the sandstone (grauwacke) which has the lithological appearance of Potsdam sandstone, lying immediately on the upturned edges of the gneiss and dipping at an angle of 45° to the N.W. The strike of the two rocks is different;—the sandstone being 15° or 20° more to the S.E. and N.E. than the gneiss. The sandstone is as near as I can judge from its limited exposure not more than 30 feet thick; the slaty limestone, which lies upon the sandstone, is somewhat thicker; perhaps 70 or 80 feet thick, and then comes a cherty limerock of great thickness. No fossils have been found in this vicinity, either in the limestone or sandstone. Dr. Kitchell, Superintendent of the late Geol. Survey of New Jersey, recognized the unconformability of the gneiss and the blue limestone and in his Annual Report for 1855, p. 138 and onwards, refers to several localities where this can be seen.

New Brunswick, N. J., July 2, 1861.

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Art. XXVI—*Chemical Contributions;* by M. C. Lea.

4. *On the Action of Nitric Acid on Picramic Acid.*

On this point very conflicting statements have been made. Girard, and Pugh, respectively state that picric acid is reproduced by the oxydation of picramic acid by nitric acid. A similar statement is made by Kolbe in his Lehrb. d. Org. Chemie (authority not given). In a paper published several years since, on picric acid, I expressed a similar opinion. On the other hand Wöhler stated that his nitrohæmatic acid (now known to be identical with picramic) was not reconverted to picric acid by the agency of nitric acid. Gerhardt too, in quoting the first opinion puts a note of interrogation after it, as if to express a contrary conviction. These differences of opinion have induced me recently to re-examine the subject and have led to the conclusion that the substance formed is not identical with picric acid. The following were the reactions observed.

Picramic acid readily dissolves in strong nitric acid to a dark brown solution. By 15 minutes boiling this becomes clear bright red. If then saturated with potash, quantities of nitrate of potash crystallize out, with much brown varnish, but no trace of picrate. After one hour's boiling the color of the solution is considerably lighter—the results much the same.

After four hours boiling the color of the liquid was bright yellow. It was evaporated in the water bath and gave a crystalline substance mixed with much resinous matter. To remove this, it was dissolved in as small a quantity of cold water as possible, filtered and mixed with half its bulk of strong sulphuric acid. On cooling, a crystalline reddish yellow substance separated which might easily be taken for picric acid mixed with resinous impurity. But neutralized by ammonia and heated with sulphydrate of ammonia it gave no indications of the presence of picric acid. Tested with cyanid of potassium the results were the same. By spontaneous evaporation of the solution of the substance in ammonia, fan-shaped groups of hair brown needles were obtained. Analysis of these showed conclusively that they consisted of *oxalate of ammonia* disguised by organic matter.

After eight hours boiling the liquid was pale straw yellow and by evaporation on the water bath yielded a substance dissimilar from the former, bright yellow, and colored intensely deep red by cyanid of potassium after previous supersaturation with ammonia. But treated with sulphydrate of ammonia, it gave no indications of the production of blood red picramate, but became greenish brown with production of a greenish precipitate. The presence of oxalic acid could not be detected.

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These experiments appear to me to leave no doubt that picric acid is not formed by the action, either brief, or prolonged, of nitric acid on picramic acid, but that resinous substances are produced, accompanied after a time by oxalic acid, which at a later stage, suffers decomposition itself. All of these substances are however produced in very small amount, the greater part of the constituents of the picric acid passing off in volatile decomposition products.

5. *On the Preparation of Picramic Acid.*

We are generally directed to dissolve picrate of ammonia in alcohol, saturate with ammonia, and then with sulphydric acid. These saturations are tedious and troublesome, and as picrate of ammonia is but sparingly soluble in alcohol much of the latter is consumed, and the solutions are very bulky. The following process will be found greatly preferable.

Picric acid (which is very soluble in strong alcohol) is dissolved in cold alcohol, and excess of sulphydate of ammonia added. The liquid then only requires to be evaporated over the water bath, the residue to be exhausted with boiling water, filtered, and treated with acetic acid. The picramic acid obtained in this way is very pure, and the quantity large. In one experiment where the quantities were weighed, over 63 per cent of the weight of the picric acid consumed was obtained. If too little sulphydrate be used, picric acid remains in the mother water from which the picramic acid crystallizes, and may be recovered by precipitating with carbonate of potash.

Philadelphia, July 13, 1861.

ART. XXVII.—*On the Production of new Coloring Matters by Decomposition of Nitronapthaline and Dinitronaphthaline;* by M. CAREY LEA, Philadelphia.

(1.)

IN the process for preparing naphthylamine by the action of acetic acid and iron on nitronaphthaline, the nitronaphthaline is placed in a retort with iron filings and acetic acid, and after the first action has passed off, the contents are heated, a receiver attached and hot lye is added to disengage the naphthylamine. But if a well cooled receiver be attached at the outset of the operation and if heat be applied for some time before the addition of the caustic alkali, a liquid passes over which exhibits the following reactions.

It has a pale reddish color and exhales the disgusting odor of naphthylamine. The pale reddish color becomes pale violet

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by addition of mineral acids. If it is placed in an open capsule and heated on the sand bath with addition of dilute sulphuric acid, the pale violet color gradually deepens in intensity to rich blue purple. After a time, a black crystalline precipitate falls which must be separated. The brown filtrate by further heating, again becomes rich purple and deposits a further quantity of precipitate. But eventually the liquid becomes muddy brown (A) and yields no more of the precipitate.

This latter is produced at best in extremely small quantity, and sometimes scarcely appears at all—a grain or two is all that can be obtained from 50 or more gramms of nitronaphthaline.

The properties of this very interesting and beautiful substance, as far as could be determined from the very scanty amount obtained for examination* were as follows. As caught on the filter, it constituted nearly black needles with a most brilliant golden green glitter. After being dissolved in alcohol, it was obtained as a dark red powder, which when placed on glass and a platinum spatula drawn a few times over it, gave a bright green, almost metallic reflecting surface, contrasting strongly with the red powder around it.

It dissolved somewhat readily in alcohol coloring it an intensely deep blood red. The addition of a very small quantity of sulphuric or nitric acid brought this through a succession of shades as the quantity of acid increased, first ruby, then crimson, then rich purple and finally blue purple, all of the richest shades, and so intense as to require great dilution to render the solution at all transparent. The substance exhibits considerable resistance to acids. The alcoholic solution acidulated with sulphuric acid may be boiled without destroying the color; if nitric acid be substituted, the solution by boiling becomes pale straw color, possibly an effect of the reaction of the nitric acid on the alcohol present.

The production of a red color by alkalies and a blue by acids is becoming characteristic of a large number of organic coloring matters. Amongst these are, the coloring matter obtained by Church and Perkins from tincture of madder; by the resinous body obtained by Schiff in the spontaneous decomposition of naphthylurea; by the body obtained by Church and Perkins from nitrosonaphthaline;† by carotin, as observed by Dr. Husemann;‡ by a blue coloring matter obtained from picric acid described by myself. The frequency of this reaction is constantly increasing as we become better acquainted with organic coloring matters.

* Much to the author's regret he was obliged to discontinue this examination in consequence of an unexplained injurious effect upon his health by manipulating with naphthylamine.

† Jahresbericht, 1857, p. 360.

‡ Chem. Centralb., May 1861, p. 347.

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The substance which I have here described would doubtless be valuable as a dye if it could be obtained in sufficient quantity, for the richness of its colors leaves nothing to be desired, but it is only a secondary product in the reaction which produces it. Until it can be obtained in sufficient quantity to admit of its constitution being determined, I propose to call it Ionnaphthine, from ἰον, *a violet.**

(2.)

If the muddy brown liquid mentioned at (A) in the 2d paragraph be treated with liquid ammonia, brown flakes separate. If these be treated with dilute sulphuric acid and bichromate of potash they become black. They then do not dissolve in water or alcohol, but dissolve in dilute nitric acid to a deep violet solution, greatly inferior however in color to the solution of ionnaphthine. This substance may possibly be identical with that described by M. Du Wildes† and obtained by him by oxydating napthylamine by means of nitrate of mercury.

(3.)

If the solution of dinitronaphthaline in alcoholic ammonia be heated with solution of sulphite of ammonia, the red solution assumes a rich deep rose color, far richer and more brilliant than the original solution. I have not as yet been able to isolate this substance.

Dinitronaphthaline is as fruitful in colored derivatives as aniline. Treated in solution in alcoholic ammonia with stannous chlorid, it yields a fine blue. Roussin's "artificial alizarine" affords fine shades of purple, the reaction is obtained with great facility. Hofmann and Wood's ninaphthylamine as I have obtained it varies from copper to sealing wax red, but does not seem to me likely to be valuable as a dye. Roussin's alizarine will no doubt be very much so.

ART. XXVIII.—*The Primordial Zone of Texas, with descriptions of New Fossils;* by B. F. SHUMARD.

IN the appendix of Dr. Ferd. Rœmer's volume of Explorations in Texas, published in 1842, we find a notice of Trilobites and other fossils from the valley of San Saba river, which are referred by the author to the epoch of the Lower Silurian system, and subsequently in his *Kreidebildungen von Texas* published in 1852, Prof. Rœmer has given a more extended description of

* The specimen of this new coloring matter which Mr. Lea has sent to us sustains all he says of its beauty.—EDS.

† Rep. de Chimie appliquée, Mai, 1861, p. 172, M. du Wildes is in error in supposing that a reaction which he has obtained is the first instance of a reproduction of an original body from a nitro-substitution compound.

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these fossils illustrated with excellent figures. For one of the trilobites Rœmer proposed the genus *Pterocephalia*, which appears to be nearly related, if not identical with *Conocephalites* of Zenker, another and unnamed species possesses all the characters of *Dikelocephalus* of Owen, while a third erroneously figured as the tail of the latter is evidently the head of an *Arionellus*.* It is scarcely necessary to inform palæontologists that these genera are confined exclusively to the Primordial Zone, to which, indeed, Mr. Barrande has already referred the Texan strata, basing his opinion upon the evidence afforded by the work of Rœmer, last cited.

We have no further account of the Primordial rocks of Texas, until 1859, when the present writer published a notice of their discovery in Burnet county (Trans. Acad. Sci., St. Louis, vol. i, p. 673,) in which their parallelism with the Potsdam sandstone and Calciferous sand group of Iowa, Wisconsin and Minnesota and the magnesian limestone series (in part) of Missouri was indicated.

Further explorations have shown that the Primordial rocks with their characteristic fauna are spread over considerable areas in the counties of Burnet, San Saba and Llano, and that they also extend into McCulloch, Mason and Lampasas, and as comparatively little is known respecting their lithological and palæontological features in this, their most southern outcrop hitherto recognized on the American continent, I propose in the present paper to give a brief description of them, drawn from a somewhat careful study of their characters at a number of localities visited by the Geological Survey.†

The Primordial Zone of Texas may be described as a series of light colored, pure and impure dolomites, limestones, chert, calcareous and silicious sandstones, gritstones and conglomerate, presenting an aggregate thickness of from eight to ten hundred feet, and separable into two well marked divisions, of which the superior represents the Calciferous sand group and the inferior the Potsdam sandstone of the northwest.

These rocks are based on reddish feldspathic granite, very similar in lithological character and composition to the granite, which occurs in the region of the Iron Mountain of Missouri, and they are succeeded by even-bedded, hard, brittle, remarkably close-textured, pure limestone and alternating beds of very compact dolomite, sometimes elegantly variegated with delicate flesh-colored cloudings. This formation, some of the beds of which resemble lithographic limestone, has received the name of Burnet marble, and may possibly represent the Bird's-eye limestone of the New York series. The fossils hitherto discov-

* It affords me pleasure to acknowledge here, that in these explorations I have been materially assisted by Prof. W. P. Riddell of the Texas Geological Survey.

† Rœmer's fossils were found in the San Saba valley, McCulloch county.

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ered in it are chiefly *Orthoceras* and *Straparollus*, but the few specimens we have found are so badly preserved that they are almost useless for the purpose of identifying the age of the formation.

Calciferous Sand Group.

This formation lies immediately beneath the Burnet marble and consists of calcareo-magnesian limestone, nearly pure limestone and chert. The usual characters of the group may be understood from the following sections:—

. Section of Falls of Deer Creek, near Colorado River, Burnet Co.:—

No. 1. Light-colored calcareo-magnesian limestone with much chert, - - - - - - - 40 ft.

" 2. Alternations of light gray, thick-bedded, compact and sub-granular, calcareo-magnesian limestone, and nearly pure white, coarsely crystalline limestone, often handsomely variegated with pink and purple. The upper beds are more compact and of finer texture than the lower, - - - - 299 ft.

" 3. Very hard, light gray dolomite with a pink tinge, 57 ft.

At Marble Falls, Colorado river, just below the mouth of Flat-Rock creek, we have an interesting section, showing the connection of the Calciferous sand group with the overlying formations thus:

No. 1. Dark, Carboniferous Limestone with Productus semireticulatus (?) Chonetes, Zaphrentis and numerous remains of Crinoidea, - - - - - - 45 ft.

" 2. Alternations of nearly pure, brittle limestone and dolomite (Burnet Marble), - - - - - 90 ft.

" 3. Thick beds of very hard, brittle limestone (Burnet Marble), 55 ft.

" 4. Calciferous sand group, consisting of light and dark gray, compact and fine-grained dolomite, in beds from one to six feet thick, - - - - - - 80 ft.

At Mormon Mills, on Hamilton creek, five miles above its confluence with the Colorado (Burnet county) we find the following section, showing the junction of the formation under notice with the Potsdam sandstone:—

No. 1. Massive beds of sub-crystalline, calcareo-magnesian limestone, variegated with brown and purple and forming rough cliffs, - - - - - - - - 290 ft.

" 2. Gray micaceous sandstone, made up of fine grains cemented with argillo-calcareous matter, - - - - 5 ft.

Thus characterized the Calciferous sand group of Texas is largely developed in the counties of San Saba, Llano, McCulloch, Menard, Mason and to a limited extent in Lampasas. Its presence may in general be recognized by the rough and picturesque appearance of the country where it prevails.

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Along the Colorado for some distance above the mouth of Brady's creek and throughout the whole course of the latter stream in San Saba county and Deer Creek in Burnet county, this formation is characterized by high castellated and mural escarpments, which are strikingly similar in their appearance to the bluffs of 3d or *Lead Bearing Magnesian Limestone* of the Osage, Gasconade, and Niangua in Missouri and those of the same geological age (*Lower Magnesian Limestone*) that escarp the upper Mississippi in Iowa, Wisconsin and Minnesota. In the districts drained by the branches of Morgan's creek in Burnet county, and toward the head of Wallace creek and various other points in the southern part of San Saba, the formation contains much chert, both compact and in the form of large rough cellular masses with cavities coated with brilliant crystals of druzy quartz. The beds are also not unfrequently traversed in various directions by spar veins. In fact they present all the characters of the productive lead-bearing rocks of Missouri and are of the same geological age. It is therefore not at all improbable that valuable deposits of lead will be found within the districts underlaid by these strata in Texas.

Fossils.—In the chert beds of the formation we have found at a few localities *Pleurotomaria*, *Ophileta* and *Orthoceratites* identical with species discovered by Prof. Swallow and the writer in the 3d Magnesian Limestone of Missouri. No fossils have yet been found in the calcareous beds of the formation in Texas.

Potsdam Sandstone.

This important division of the Primordial zone in Texas has a thickness, estimated at not less than five hundred feet. The sections given below taken by the writer in Burnet county, assisted by Dr. W. P. Riddell and S. Heron, Esq., will serve to show the character of the different beds that constitute the mass.

Section at a small creek, five miles N.W. of the town of Burnet:—

No. 1. Soft, chalky limestone with well marked cretaceous fossils, 50 ft.

" 2. Gray and bluish gray, hard limestone, of a sandy texture, in beds from a few inches to a foot thick, and containing *Arionellus* (*Bathyurus* (?) *planus*, *Bathyurus depressus*, *Camerella* sp., *Orthis Coloradoensis*, *Orthis* sp.? *Discina microscopica* and *Lingula* sp.? - - - - - - 81 ft.

" 3. Mottled gray, purple and greenish, earthy and sub-crystalline limestone, with alternating bands of silicious limestone—contains the same fossils as No. 2, - - - - 45 ft.

" 4. Slope with projecting ledges of No. 3, - - 55 ft.

" 5. Slope, - - - - - - - 24 ft.

" 6. Schistose coarse-textured limestone, made up of crystalline particles and abounding with fragments of trilobites, chiefly *Arionellus*, - - - - - 20 ft.

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Section taken about one mile south of the preceding at head of Clear creek:—

No. 1. Cretaceous strata in horizontal beds, - - - 110 ft.

" 2. Slope, covered with conglomerate, composed of pebbles of sandstone and calciferous sand rock, rather firmly cemented, 12 ft.

" 3. Potsdam sandstone, consisting of thin layers of varicgated green, gray and purplish, sandy limestone, with bands of dolomite and silico-calcareous rock interstratified. Some of the beds are highly charged with trilobites, of which the most common are *Arionellus Texanus*, *Dikelocephalus Rœmeri* and *Conocephalites Billingsi*, - - - - - 40 ft.

" 4. Highly ferruginous silicious sandstone, composed of fine grains, loosely cemented, passing downwards into coarse gritstone and conglomerate. The upper beds contain *Lingula* and *Obolus* (?) - - - - - - - 60 ft.

" 5. Flesh-colored granite, interstratified with veins of milky quartz, - - - - - - - - 6 ft.

Section near mouth of Morgan's creek:—

No. 1. Coarse-textured, variegated purple, green and brown limestone, soft and crumbling readily to sand, - - - 52 ft.

" 2. Greenish and gray calcareous sandstone made up of fine grains, - - - - - - - - 8 ft.

" 3. Slope, with projecting ledges of white, green and gray limestone with *Conocephalites Billingsi*, *Agnostus Coloradoensis* and *Arionellus*, - - - - - - 27½ ft.

" 4. Thin beds of calcareo-silicious limestone with same *trilobites* as No. 3, - - - - - - - 60 ft.

" 5. Brown ferruginous sandstone with *Lingula*, - - 60 ft.

" 6. Flesh-colored granite, - - - - 110 ft.

The best exhibitions of this group of rocks occur in the region of Morgan's creek and its tributaries in Burnet county. The remarkable elevation in this region, known as the "Tatur Hill" is composed of this rock. This hill is of truncated conical form, and rises to the height of two hundred and eighty-four feet above the adjacent valley. The Potsdam sandstone is also finely displayed in the southern part of San Saba county and around the margins of the granite districts in Llano. Near the granite the strata are in places highly metamorphosed and disturbed as in the Colorado, near the mouth of Slick-Rock creek, Burnet county, where they are inclined at an angle of nearly 45°.

The fauna of this division of the Primordial Zone of Texas is very analagous to that of the Potsdam sandstone of Iowa, Wisconsin and Minnesota. I have not been able to discover any species common to the two districts but most of the genera are identical. Thus in the Texan beds we have found *Dikelocephalus*, *Bathyurus*, *Arionellus*, *Conocephalites*, *Agnostus*, *Lingula*, *Discina*, *Orthis*, *Camerella*, *Obolus* and *Capulus*, all of which

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genera have been discovered in the Primordial sandstones of the northwest except *Agnostus* and *Camerella*.

Compared with the Primordial rocks (Quebec group) of Point Levi, Canada, recently so well described by the Canadian geologists, the Texan strata may be placed on a parallel with the beds provisionally designated as A^2 by Sir W. E. Logan (this Jour., vol. xxxi, p. 216). The propriety of this reference will become apparent by comparing the above-mentioned Texan genera with the following list of fossils given by Logan as occurring in A^2 at Point Levi, viz:—Orthis, Leptena, Camerella, Lingula, Discina, Agnostus, Conocephalites, Arionellus, Dikelocephalus and Bathyurus.*

Descriptions of New Species.

TRILOBITES.

Agnostus Coloradoensis, n. sp.

Head small, nearly circular, convex, length and breadth nearly equal, surrounded with a narrow, neatly defined, flattened border, between which and the dorsal furrows is a small regularly convex surface. Glabella convex, narrow-conical, most elevated posteriorly, occupying scarcely two-thirds the total length of the head, and not quite as wide as one of the cheeks. A single transverse furrow situated near the front divides the glabella into two unequal portions, and at the base on either side is a small triangular lobe. The glabella is strongly separated from the cheeks and front border by a deep furrow.

Length of head, 0·10 of an inch.

A single example only of this species has come under my observation. It bears a close resemblance to *A. orion*, a species recently described by Mr. Billings from the Primordial limestone of Point Levi, opposite Quebec. The *A. Coloradoensis* is, however, a much smaller species, the glabellar furrow is situated much nearer the apex and there is no fissure extending from the glabella to the anterior margin, as occurs in the Canadian species.

Found in Burnet county, near mouth of Morgan's creek associated with *Conocephalites Billingsi* and *Arionellus depressus*.

Arionellus (*Bathyurus*) *Texanus*, n. sp.

Head large, approaching semicircular, wider than long; glabella somewhat regularly convex, conical, distinctly separated from the sides and front by a deep groove; neck-furrow distinctly impressed on the sides and nearly obsolete in the middle; border in front of the glabella broad, occupying about one-third the entire length of the head, and marked posterior to the middle with a deep, and rather wide, transverse furrow, which is parallel with the front margin, and has three deep transverse pits; anterior to this furrow is a broad, smooth space sloping from the front

* The genus *Bathyurus* of Billings appears to me to be closely related to *Crepicephalus* of Owen, and both present many points of resemblance to *Arionellus* of Barrande.

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margin to the furrow. A line drawn transversely across the middle of the glabella, if extended would pass nearly through to the centre of the eyes. The facial suture passes forward from the inner anterior corner of the eye, nearly parallel with the axis of the body, until it reaches a point opposite the extremity of the furrow of the front margin, thence obliquely forwards and inwards to the front edge; behind the eye it turns suddenly outwards and slightly backwards and cuts the posterior border near the genal angle.

Pygidium short and somewhat massive, subelliptical, axis approaching semicylindrical, elevated above the lateral lobes, as wide as one lateral lobe, and occupying about two-thirds the length of the pygidium; rings four, separated by deep furrows; posterior margin gently arched in the middle and armed on either side with a long, curved, diverging spine (about eight lines long); lateral lobes gently convex, segments indistinct.

Locality.—This is the largest species of the genus I have seen. It occurs in coarsely crystalline limestone of the age of the Potsdam sandstone, at the head of Clear creek, Burnet county.

Arionellus (*Bathyurus*) *planus* (n. sp.).

Head rather large, approaching semicircular, moderately elevated, having a wide border in front, which slopes from the glabellar furrow to the front margin. Glabella convex, oblong, separated from the cheeks and front by a shallow furrow, elevated above the cheeks, sides straight, slightly converging from the neck segment to the anterior extremity; neck furrow shallow, but distinctly defined entirely across; neck segment convex, arched posteriorly and not as high as the glabella. There are several specimens of the glabella of this species in the Texas State Collection, none of which show any traces of transverse furrows.

Length of head, 0·93; length of glabella, 0·54; width at apex, 0·32; width at base, 0·40.

In general appearance this species resembles *Bathyurus armatus* of Billings, but the glabella of our trilobite is strongly elevated above the general convexity, which is not the case in the Canadian species.

Locality.—In the Potsdam sandstone, head of Morgan's creek, Burnet county, associated with *Orthis Coloradoensis*, near the top of the formation.—Texas State Collection.

Conocephalites depressus (n. sp.).

Glabella not much elevated, most convex in the middle, equal to about two-thirds the length of the head, its contour well-defined by the dorsal furrows; sides nearly straight and gradually converging toward the front, which is rounded, lobation indistinctly marked by obscure lateral furrows, neck furrow well defined but not deeply impressed, border in front of the glabella wide, convex, having an elevated marginal rim in front and just within the rim a distinct groove. Surface in front of the glabella marked with very fine, longitudinal, undulating raised lines; no other surface markings visible on any of the specimens under examination.

Length of the head 0·42 of an inch; length of glabella 0·28; width of glabella at base 0·23, at apex 0·16.

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This species is closely related to *C. Wisconensis* Owen, specimens of which I have in my cabinet from the Potsdam sandstone of Lake Pepin, Wisconsin. The glabella is, however, proportionally shorter and the front border wider in the Texan fossil.

Locality.—Head of Clear Creek, Burnet county. Texas State Collection.

Conocephalites Billingsi (n. sp.).

Glabella conical, tumid, occupying about three-fourths of the entire length of the head, about one-third longer than wide, outline strongly defined by the dorsal furrows, which are deeply excavated; neck-furrow strongly impressed, lateral furrows three on either side, deeply impressed, the posterior ones curving inwards and backwards from the dorsal nearly to the neck furrow and reaching rather more than one-third the distance across the glabella, middle furrows curved and reaching scarcely more than one-fourth the distance across—anterior furrows quite short, and shallower than the others; neck segment much elevated, convex, having a small median tubercle which is directed obliquely backwards, and has a small central pit, apparently for the articulation of a slender movable spine; front border occupying about one-fourth of the length of the head, margined in front with an elevated rim, between which and the glabellar furrow is a convex surface. Test thin and apparently quite smooth.

Length of head, 0·33 inch, width of base of glabella 0·16.

Of this well marked species of *Conocephalites* we have discovered only portions of the head of several individuals, consisting of the glabella, and immovable cheeks. They were found in gray coarsely crystalline, thin-bedded limestone near mouth of Morgan's Creek, Burnet county.

The species is named in honor of E. Billings, Esq., Palæontologist of tho Geological Survey of Canada.

Dikelocephalus Rœmeri (n. sp.).

Head approaching semicircular, obtusely subangular in front, having a broad border, with a moderately elevated marginal rim, a groove just within the rim, and between this and the glabellar furrow a convex surface. Glabella convex, elevated, and, including the neck segment, occupying not quite two-thirds the total length of the head; sides straight, slightly converging towards the front, which is moderately arched. The transverse furrows are distinctly marked and divide the glabella into three lobes. The posterior furrow is strongly arched backwards and extends quite across, joining the dorsal furrows a little behind the middle of the glabella. The anterior pair curve backwards, reach about one-third the distance across and are situated in advance of the middle. The dorsal furrows are moderately impressed and distinctly limit the sides of the glabella.

Pygidium short, having a broad slightly excavated smooth border, whose outline is convex on the sides and slightly excavated behind, axis prominent, narrow-conical about as wide as one lateral lobe, excluding the border, contracted at apex, separated from the lateral lobes by a distinct but somewhat shallow furrow; rings five, rather wide, separated by shallow furrows, the last two or three of which are indistinct, lateral lobes

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gently convex, sloping very gradually from thoracic margin to border; segments four or five, wide, flattened convex, the anterior one more elevated than the others, posterior ones nearly obsolete.

An excellent figure of the head of this species is given by Dr. Rœmer in his "*Kreidebildungen von Texas*," (Taf. xi, fig. 2, a), but the author has proposed no name for the species. Fig. 2 c–d of same plate belongs to the head of an *Arionellus*, which has been erroneously referred to the pygidium of this species.

Occurs in crystalline gray limestone, of the age of the Potsdam sandstone, at the head of Clear creek, Burnet county, associated with *Arionellus Texanus*.

Named in honor of Prof. Ferd. Rœmer.—Texas State Collection.

BRACHIOPODA.

Discina microscopica (n. sp.).

Shell very minute, conico-subquadrate, much elevated, nearly as high as long; vertex, nearly or quite marginal, and marked with a small pit; area triangular, flattened, extending from apex to posterior margin. Surface marked with extremely fine, concentric lines of growth.

This is an extremely minute species, the largest specimen being scarcely more than $\frac{5}{100}$ of an inch in length.

A few examples of this species were found in the Potsdam sandstone, near the sources of Morgan's creek, Burnet county. It is associated with *Arionellus Texanus* and *Orthis Coloradoensis*.—Texas State Collection.

Camerella (sp.?).

There are several specimens of a small brachiopod in the Texas State Collection, from the Potsdam sandstone of Morgan's creek, Burnet county, which appear to belong to the genus Camarella recently created by Mr. E. Billings. Unfortunately, however, they consist merely of detached and imperfect valves, too much weathered for satisfactory determination and description.

GASTEROPODA.

Capulus (sp.?).

A small, smooth species of *Capulus* with flattened sides, convex dorsum and narrow curved apex, occurs with the preceding at Morgan's creek, Burnet county, but the characters are not sufficiently distinct to warrant us in giving a description of it.

St. Louis, June 12, 1861.

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ART. XXIX.—*On the constitution of the Planetary System: and on the theory and tables of Mars, (in a letter addressed to Marshal* VAILLANT); by M. U.-J. LEVERRIER, Director of the Observatory of Paris.*

THE interest which you have taken in the advancement of astronomy and of our knowledge of the system of the world, has induced you to follow with kind regard, my protracted investigations of the four planets, Mercury, Venus, Earth and Mars. It gives me satisfaction to announce to you the completion of these researches;—the last part, relating to the motions of Mars, is finally ended.

The most practical result of these labors is doubtless by comparing theory with observations, to render astronomical tables more precise. Yet the hope of making the tables of the planetary motions absolutely exact, seems insufficient to induce an astronomer to undertake a heavy task of 15 to 20 years, were he not sustained by the thought that he might at least prepare the way for some new discovery:—an ambitious thought, but one which has prompted more than one laborious enterprise. Did not the illustrious astronomer of Königsberg confess that the theory of the Sun had not made the progress which we might have expected from the great number and precision of the observations thereof?

Laying aside long formulæ and tedious calculations, immense series of observations and dry tables of numbers, in short, all professional apparatus, I will here speak only of the results of my labor so far as it relates to the physical constitution of our system.

The existence of the bodies of our system is made known in the most simple manner, when we see them. There is reason to fear, however, that more than one of them may escape us, if, confining ourselves to direct vision as the means of investigation, we do not by some independent method make up for the deficiency of our eyes, even when provided with the most powerful optical apparatus.

The planes of the orbits in which the planets move suffer displacement in the lapse of time, in consequence of the action of masses exterior to the sun; the same is true of the position of the perihelion of the orbits, and the forms of the orbits even undergo alteration. It is evident that the amount of these changes, ascertained by observations, may serve to determine the weight of the bodies which produce them.

Further, were it to be supposed that the only disturbing masses were those of the known planets, it would necessarily result that the variations of all the orbits would agree in giving

* From *Comptes Rendus de l'Acad. des Sciences*, of June 3, 1861.

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the same values for these masses; if it shall not, some foreign cause must of necessity have been omitted.

The question presented itself nearly in the following form. Would it be possible by assigning suitable masses to the known planets to satisfy all the observations? Or is there somewhere in our system a notable quantity of matter, which, as yet, has not been taken into account, and of which the consideration is indispensable?

The separate study of each one of the planets affords no answer to this question, whereas the comparison of all the results together enables us to decide with certainty. I will take then the new theory of Mars, and from my previous works, so much as is necessary to the end actually sought, but nothing more.

The position and small size of Mercury and Mars prevent them from exercising any important influence upon the bodies of our system. Observations upon Venus enable us to estimate the mass of Mercury as one five-millionth ($\frac{1}{5\,000\,000}$) of that of the sun; while the motion of the earth, deduced from observations of the sun, indicates the mass of Mars as one three-millionth ($\frac{1}{3\,000\,000}$) that of the sun. The uncertainty which may exist in these numbers has no influence upon that which follows.

The mass of Venus is about one four-hundred-thousandth ($\frac{1}{400\,000}$) that of the sun. This result is obtained by several methods; by the consideration of the displacement of the plane of the ecliptic; by the actual measurement of the periodical perturbations of the earth from 1750 to 1810, and from 1811 to 1850; and by the amount of the periodical inequalities of the longitude of Mercury. These results all confirm each other.

The mass of the earth is one three-hundred-and-fifty-five-thousandth ($\frac{1}{355\,000}$) of that of the sun. This number is derived from a comparison of the force of gravity upon the earth, with the fall of our own planet toward the sun.

These being the data, the theory of Mars may be established by means of them, and compared with meridian observations made a century since, also with observations made upon the near approach of Mars to the star Ψ_2 Aquarii, which were made in the year 1672, at Paris by Cassini and Roëmer, at Cayenne by Bouguer who went there to investigate atmospheric refraction, the obliquity of the ecliptic, and the parallax of Mars.

Now, I have discovered that it is not possible to satisfy in this manner, all the observations of the planet; to do this completely, it is necessary to increase the motion of the perihelion of Mars. This increase, if it could be deduced from a change in the received values of the masses of the planets, could not come from a modification of the mass of Venus (for it does not exert a sufficient influence upon the movement of Mars), but only from an addition to the mass of the earth, an addition which it would be necessary to make equal to the *tenth* part of the value given above.

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We shall discuss, farther on, the consequences of this result, confirmed as it is, moreover, by a deduction from the theory of Venus. The increase in the latitude of this planet, leads us to a rigorous condition which can only be satisfied by augmenting the mass either of Venus, or of the earth. In publishing the theory of Venus, I had already remarked that the considerations referred to above, would not allow any change to be made in the mass of Venus; that it appeared necessary therefore, to increase by a *tenth* part the mass of the earth; that in view of the importance of this conclusion, it were better, before deducing the consequences of it, to await the completion of the theory of Mars. Now, as we have just seen, the theory of Mars itself demands that we increase the mass of the earth by *exactly* a *tenth*.

I should remark, before proceeding, that Mercury has already given me a result of the same kind. Observation assigns to the perihelion of this planet a more rapid motion than that which corresponds to the masses above admitted. A change of a *tenth part* in the mass of the earth, will not account for this fact; and as it is impossible to increase the received mass of Venus, I have hence inferred the existence of a ring of masses of matter within the orbit of Mercury. The subject has already been discussed, and will be still farther prosecuted; it may not be unprofitable to repeat the language in which I announced my opinion (*Annales*, t. v, p. 105):

"As a mechanical problem we might satisfy the observed transits of Mercury across the sun, on the hypothesis of a perturbing body, whose place is to be determined. It is however indispensable to consider whether all solutions equally satisfy the physical conditions.

"At the mean distance of 0·17, the disturbing mass would be exactly equal to that of Mercury. The greatest elongation which it could attain would be a little less than 10°. Must we believe that a planet shining with a brilliancy more vivid than that of Mercury, would necessarily have been perceived, grazing the horizon, after the setting, or before the rising of the sun? Or is it possible that the intensity of the dispersed light of the sun would have enabled such a star to escape detection?"

"At a greater distance from the sun the disturbing body must be less considerable, and the same would also doubtless be true with regard to its volume, but the elongation would be greater. Nearer the sun, the contrary would be true, and, although the brilliancy of the disturbing body would be increased in consequence of its size and nearness to the sun, it is possible that a star whose position was unknown, might not be perceived in ordinary circumstances."

"But, even in this case, how could a large body having a great brilliancy and situated always near the sun have escaped being seen during some of the total eclipses? Finally, could such a body pass between the solar disk and the earth, and not be recognized?"

"Such are the objections which might be urged to the existence of a single planet, comparable to Mercury as regards its dimensions, and re-

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volving within its orbit. Those to whom these objections appear too serious will be led to replace this single planet by a series of asteroids, the sum of the actions of which would produce the same effect upon the perihelion of Mercury. Aside from the fact that these asteroids would be invisible under ordinary circumstances, their distribution about the sun would prevent their introducing in the motion of Mercury, any periodical inequality of much importance."

"The hypothesis to which we find ourselves conducted, contains nothing extravagant or incredible. A group of asteroids is found between Jupiter and Mars, of which doubtless only the principal individuals have as yet been discovered. There is even reason to believe that the planetary spaces contain an infinite number of very small bodies revolving about the sun. This is certainly true with regard to the region adjacent to the orbit of the earth."

The principal difficulties presented by the system of the four inferior planets, are reduced then to an excess of movement of the perihelion of Mercury, and that of Mars. This two-fold conclusion is worthy of attention; for if the cosmical matter has such a disposition, that although partly or wholly invisible it acts in such a manner as to increase the direct motion of the perihelion, having but little influence apart from this, it is easy to see how the existence of this matter in this condition becomes highly probable.

Now this is, in fact, the mode of action of a series of minute bodies forming a ring about the sun, and revolving from west to east, in the same direction as the other planetary bodies. These bodies, as a whole, could scarcely change the excentricity of the orbit of a planet or cause any sensible periodic inequality in the longitude. Their effect upon the perihelion, however, might become considerable, since it is the sum of the separate effects of each one, so that the final result is sensibly the same as if the whole amount of matter was concentrated in a single mass. Such are the considerations which have induced me to admit the existence of a ring of intra-Mercurial asteroids. The theory of Venus and that of Mars now unite, in confirming these conclusions.

Let us return to the examination of the causes which acting at the other extremity of the system of inferior planets, serve to increase the motion of the perihelion of Mars. They can be accounted for, as we have said, by supposing the mass of the earth increased by a *tenth part*. The motion of Venus in latitude demands the same increase of cosmical matter; but, on the other hand, there is a difficulty with regard to the parallax of the sun.

These demands can all be satisfied and the difficulties all made to disappear by admitting that the asteroids, which, according to observation are situated at the same distance from the sun as the earth have a total mass equal to the *tenth* of that of

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the earth. This group of asteroids would accelerate the motion of the perihelion of Mars just as an addition of a *tenth* to the mass of the earth would do. If it is situated very nearly in the ecliptic, it will produce the same effect upon the orbit of Venus. It will have, moreover, no influence upon the periodic terms of the perturbations of Venus and Mars. Finally the relation existing between the mass of the earth, gravity and parallax of the sun will not be altered.*

At the beginning, we had hoped that it would be possible to derive the true mass of the earth from the periodical perturbations of Mars, and from its secular perturbations, some knowledge of the total mass of the asteroids situated between Mars and Jupiter.

The first part of this attempt has only half succeeded, on account of the peculiar circumstances of the observations. There was simply reason to believe it unnecessary to increase the mass of the earth. We see at once what high interest attaches to the direct determination of the velocity of light, and, in consequence, of the amount of the solar parallax. We should thus solve a nice question.

The estimation of the total mass of the small planets situated between Mars and Jupiter, becomes impossible if the group of asteroids which is found at the same distance from the sun as the earth is admitted to have any influence. There being no means of separating completely the effects of these two groups, it is only possible to assign the superior limits of their masses, by attributing to each of the groups successively the whole excess of the movement of the perihelion of Mars. It is thus determined, that the whole amount of matter constituting the small planets situated between the mean distances 2·20 and 3·16 cannot exceed about one-third of the mass of the earth.

The constitution of the inferior (or intra-Jovial) portion of our planetary system, deduced from a discussion of observations, may then be summed up as follows:

1st. *Besides the planets, Mercury, Venus, Earth and Mars, there exists between the sun and Mercury a ring of asteroids whose mass is comparable with the mass of Mercury itself.*

2d. *At the distance of the earth from the sun, is found a second ring of asteroids whose mass is not greater than the tenth part of the mass of the earth.*

3d. *The total mass of the group of small planets situated between Mars and Jupiter is not greater than the third part of the mass of the earth.*

* It is true, that from the determination of the lunar equation of the earth, we have found that both the earth's mass and the solar parallax should be increased. But this result depends on so small a fraction of the lunar equation that we should be fully justified in disregarding it. The final data discussed above have far greater precision.

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4th. *The masses of the last two groups are complementary to each other. Ten times the mass of the group situated at the distance of the earth, plus three times the total mass of the small planets between Mars and Jupiter, form a sum equal to the mass of the earth.*

The last conclusion depends upon the determination of the distance of the earth from the sun by observations of the transits of Venus, a determination which astronomers agree in considering as very accurate.

ART. XXX.—*Upon some Improvements, proposed by Sir David Brewster, in the Photographic Camera;* by EDWIN EMERSON, of Troy Univ., N. Y.

SIR DAVID BREWSTER in his "Treatise on the Stereoscope" repeatedly and earnestly insists on the importance of taking the photographic negatives by a lens of very small aperture; he gives as a general rule, (p. 177,) "an aperture as large as the pupil of the eye;" and he makes, also, the following declaration, —"I have no doubt that when chemistry has furnished us with a material more sensitive to light, [than that possessed in 1856,] *a camera without lenses and with only a pin-hole will be the favorite instrument of the photographer;*" in the mean time, however, he suggests that "the use of a lens of rock-crystal, which has a low dispersive power, and having the ratio of the curvature of its surfaces as six to one, with an aperture of one-quarter of an inch, would make an approximatively perfect camera." (pp. 137, 138).

Being convinced, by the excellent results obtained by myself, that a small aperture was indispensable to success in point of sharpness, which was a confirmation of Sir David Brewster's main idea, and having been furnished, by my friend Prof. Rood, with an instantaneous collodion, I began to test by careful experiments, Brewster's notion of a pin-hole camera, and also the use of a quartz lens for the camera, I also endeavored to determine approximatively how small the diaphragm of the ordinary photographic camera should be reduced so as to secure the best results. The instrument in my possession is a very excellent stereoscopic camera, fitted with two portrait combination tubes, and the best achromatic lenses, of Harrison's make. The results were either obtained by this camera or were compared with its work.

Photographers generally focus upon the ground glass of the camera with the unaided eye, and, of course, in a majority of instances get only an accidental approach to a perfect focus; and when the aperture is over half an inch, for lenses of 6 or 8 inches focus, only a small portion of the whole picture is in focus at all.

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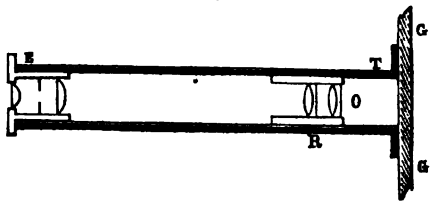
Those who use a magnifying glass and a smaller diaphragm succeed better, but by neglecting to reduce the diaphragm to a minimum, their results are by no means as perfect as they might be. By the aid of a common magnifying-glass one and a half inches in focal length, with which to view the image on the ground glass of the camera, and an aperture of two fifths of an inch in the diaphragm in taking the negative, I was able without any difficulty, to obtain results fully equal in point of sharpness, to the best French transparent views. But in attempting to improve upon this, by reducing the aperture and by increasing the power of the focusing-lens, two difficulties were experienced,—1st. The light was so much diminished that it was well-nigh impossible to see minute shades of difference in the sharpness of definition, and, 2d. The inequalities of the finest ground glass were so much enlarged as seriously to obscure and distort the view projected upon it. This last proved an insuperable bar to any higher degree of excellence by these means, as a single irregularity in the ground glass was magnified quite enough to obscure many fine details. Moreover, with a small diaphragm of the size recommended by Brewster, the light was so faint that a variation of half an inch in the distance of the lenses of the camera from the ground glass, produced no *perceptible* variation in the sharpness of the image. A series of experiments was then made with two objects in view,—1st, to carry up the power of the focusing lens, and, 2d, to subsitute for the ordinary ground glass of the camera something of finer texture so as to stand the microscopic enlargement, and of more transparent quality so as to increase the light. An ordinary "Fothergill plate," covered with the delicate yellowish film of iodid of silver enabled me to carry the magnifying power to fifteen diameters with an aperture of one-fifth of an inch. At the suggestion of Mr. Grunow, of New York, a plain glass plate, lightly covered with dust was tried, which with a power of fifteen diameters rendered practical the employing of an aperture of three-fifths of an inch. But in all the experiments with a single microscope the focus was too indefinite and uncertain for the accurate work I had in view, although the sharpness obtained was far beyond anything I had seen produced by the professional photographers. Indeed, among both British and American artists and amateurs in photography there seems to be a wide difference of opinion as to what may be regarded as *a standard* on this important point. I have not seen a suggestion of the proper means of determining it; which is, undoubtedly, an appeal to the compound microscope.

At this stage of the investigation Prof. Rood constructed for me a compound microscope of a power of thirty diameters, which I hoped to be able to employ as a focuser. Its form and construction will appear from the following diagram, fig. 1.

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This instrument I had intended to use upon the focussing plate of plain glass delicately covered with dust; but it occurred to me that possibly plain glass alone would answer to focus upon, and if so, all the obstruction caused by magnified particles of dust, and the want of sufficient light caused by the opacity of the Fothergill film, or anything of a similar character, might be entirely overcome. A trial showed that the amount of light was very greatly increased; but I was now unable to determine the position of the image projected by the lenses of the camera. The lenses of the camera in connection with the lenses of the microscope formed a telescope of considerable power, the lenses reciprocally supplementing each other, so that no matter where the image produced by the lenses of the camera might be formed in space, the microscopic focusser could be readily adjusted to suit it, and give a perfect view. To obviate this uncertainty, fine parallel lines were drawn by a diamond, one-twentieth of an inch apart, upon the surface of the plain focussing-glass nearest to the lenses of the camera; the microscope was then carefully adjusted to distinct vision of these lines, and its lenses fixed in that position; it was now easy to cause the image formed by the camera to coincide in position with these parallel lines, and thus the perfect physical focus for the sensitive plate was absolutely determined, allowance, of course, being made for any difference between the chemical and visual foci, which this arrangement afforded a means of adjusting with the greatest accuracy.

1.



G, Polished plate glass substituted for the ground glass, having fine lines drawn by the diamond on the surface farthest from the microscope.—O, Achromatic objective.—E, Eye-piece.—R, A rack-work at R moves the objective in and out.—ET, Exterior tube with a projection at the objective end at right angles, so as to apply it accurately ro the flat surface of the glass.

By this method of focussing very small objects, such as a single leaf of an elm tree over half a mile distant, were distinctly visible, and were readily focussed upon; and, also, the difference in the focus of objects at a mile, and those at a mile and a half in distance was made apparent; which is utterly beyond the power of the single microscope. The use of a very small diaphragm enabled me now to secure the finest details in all the objects visible in an extended landscape, so that they would bear examination under the compound microscope with a power of 150 to 200 diameters; or, in other words, with a power as high as the structure of the collodion would bear. Up to this time I had supposed that the lenses of my camera were of the same focal length, as very delicate manipulations had failed to detect any discrepancy between them; but by this method of focus-

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sing, a variation of nearly one-fifth of an inch was detected immediately. By the use of the instrument the aperture was reduced to one-tenth of an inch, which from careful experiments I regard as about the minimum for good results, for lenses of six inches focus.

I was now prepared to test the ideas of Sir David Brewster, 1st, with regard to a small aperture, 2d with reference to a rock-crystal lens, and 3d, as to a pin-hole alone substituted for a lens, in connection with a very rapid collodion. By means of the binocular camera I was able to make two experiments simultaneously, on the same plate, the left-hand view being taken by the portrait combination, and the right-hand view being taken with a quartz lens, or a common glass lens, or a pin-hole, as the case might be. The scenes or objects photographed were always exposed to the full light of the sun; and the plate, in each pair of experiments, was, of course, subject to a uniform treatment, under similar conditions as to collodion, baths, &c. I was thus able to compare the results of the various experiments side by side with the action of the achromatic combination; as follows—

Portrait combination, 6 inches focus.

1. One second exposure, $\frac{1}{4}$ inch diaphragm. A pretty fair negative.
2. Thirty seconds exposure, $\frac{1}{4}$ inch diaphragm, good negative, would stand a magnifying power of 30 diameters.
3. Two minutes exposure, $\frac{1}{10}$ inch diaphragm, strong negative, view sharp all over the field, would stand a magnifying power of 100 diameters.
4. Two and a half minutes exposure, $\frac{1}{12}$ inch diaphragm, negative good, but would not stand a power of over 50 diameters.
5. Pin-hole diaphragm, could see nothing distinctly to focus upon, four minutes exposure, very faint impression on the sensitive plate.
6. Pin-hole diaphragm, seven minutes exposure, strong negative, but no fine details.
7. Common glass lens, 6 inches focus, $\frac{1}{10}$ inch diaphragm, two minutes exposure, view sharp, would stand 30 diameters, tolerably.

Quartz lens, 6 inches focus.

1. One second exposure, $\frac{1}{4}$ inch diaphragm. Action slightly quicker, negative pretty fair, but less sharp.
2. Thirty seconds exposure, $\frac{1}{4}$ inch diaphragm. Action slightly quicker, more contrast, but would not stand a magnifying power of 5 diameters.
3. Two minutes exposure, $\frac{1}{10}$ inch diaphragm, no quicker action, no stronger negative, and would not stand a magnifying power of 5 diameters.
4. Two and a half minutes exposure, $\frac{1}{12}$ inch diaphragm, no quicker action, negative would only stand a magnifying power of 4 or 5 diameters.
5. Pin-hole diaphragm. Similar result.
6. Pin-hole diaphragm. Similar result.
7. $\frac{1}{10}$ inch diaphragm, two minutes exposure, quartz action quicker than the glass, more intense negative, but not as sharp, owing possibly to a slight double refraction in the lens.

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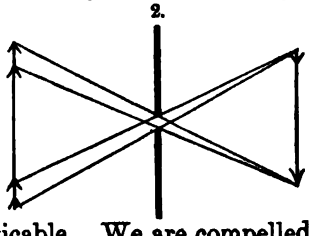
Portrait combination, 6 inches focus.	*Pin-hole alone.*
1. One second exposure, one inch diaphragm, a good negative.	1. One second exposure,—result nothing.
2. Thirty seconds exposure, half inch diaphragm, a good negative.	2. Thirty seconds exposure, result almost nothiug.
3. One minute exposure, $\frac{1}{4}$ inch diaphragm, good sharp negative.	3. One minute exposure,—faint shadowy outline of a picture.
4. Two minutes exposure, $\frac{1}{10}$ inch diaphragm, excellent negative, details of objects with a mile good under a magnifying power of 100 diameters.	4. Two minutes exposure, middling contrast between light and shade but exceedingly blurred in all the details.
5. Three minutes exposure; picture over-exposed, with $\frac{1}{10}$ inch diaphragm.	5. Three minutes exposure, view of a white bust in the sun-light, good contrast of light and shade, picture only of the prominent outlines looked like a very rough mosaic.
6. Three minutes exposure, $\frac{1}{12}$ inch diaphragm, good negative, but not sharp enough for a power of 50 diameters.	6. Seven minutes exposure, negative strong enough to print from; but no sharpness at all; details blurred and confused.

The results of these experiments may be summed up as follows:—

1. It is found in practice that a quartz lens is quicker in action than a common glass lens of the same aperture, focus and thickness.

2. A quartz lens is very slightly quicker than the double combination of achromatic lenses; but it will not afford any thing like so sharp details even under the smallest diaphragms. "A quartz lens camera with $\frac{1}{4}$ inch aperture" is, therefore, very far from being "an approximatively perfect camera."

3. The simple pin-hole will not compare under any circumstances with the commonest glass lens; as it gives no sharpness to the picture, and requires from three to seven minutes exposure, with the most sensitive collodion. This lack of sharpness might have been predicted theoretically. To give sharpness to the image, the pin-hole must be as small as the smallest detail in the view required, say the ten-thousandth of an inch, otherwise the rays of light from a single point travelling such paths as are indicated in the diagram produce necessarily a blurred image; thus—(fig. 2,) i. e., sharpness will be in proportion to the smallness of the pin-hole; now as a pin-hole of the $\frac{1}{10}$th of an inch in diameter requires with the most sensitive collodion an exposure of several minutes, it is apparent that a hole the ten-thousandth of an inch in diameter would require an exposure entirely impracticable. We are compelled,



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therefore, to regard Sir David Brewster's pin-hole camera as an optical as well as a photographical absurdity.

4. The diaphragm for lenses 6 inches in focus, can be reduced down to about an aperture of one-tenth of an inch with a very decided improvement in sharpness, if the compound microscope is used to focus with on a plain glass focussing plate; but when we reduce the aperture below this there is a loss of sharpness; owing, it may be, to the approximate parallelism of the rays.

5. A good use for a pin-hole camera would be as a simple instrument for testing the sensitiveness of collodions, and I would recommend it for this purpose.

Troy University, August, 1861.

ART. XXXI.—*On the Age of the Red Sandstone formation of Vermont;* by E. BILLINGS.*

I HAVE lately been examining a tract of the Calciferous sandrock which lies on the boundary line between Canada and Vermont on Missisquodi Bay. The rock is exposed here in long parallel ridges, over an area of eight or nine miles in length and from one to three in width. On the east side of the exposure there is a ridge of greyish sandstone which I traced south across the boundary line, after crossing which it soon becomes interstratified with thick beds of rock of a chocolate red or brown color. It is here the typical red sandrock formation of Prof. Adams. Hearing that Dr. G. M. Hall and Rev. J. D. Perry of Swanton had discovered trilobites near this place I called upon them and they kindly conducted me to the locality. It is above two miles south of the line and one mile or a little more east of the Highgate Springs. The individual fossils are abundant in the red sandstone but I could find only two species, a small *Theca* and a *Conocephalites*. Of the latter we found only the head but the specimens are very numerous and some of them well preserved. The species resembles Bradley's *C. minutus* but is a little larger and I think quite distinct therefrom. It is a true primordial type and if we are to be guided at all by Palæontology we cannot regard this rock as lying at the top of the Lower Silurian but at the very base of Barrande's Second Fauna if not indeed a little lower. It is therefore not the Medina Sandstone but a formation somewhere near the horizon of the Potsdam. This accords exactly with conclusion drawn from the evidence afforded by the fossils discovered by our survey at Quebec last year.

Museum of the Geological Commission, Montreal, Canada, July 22, 1861.

* In a letter to one of the Editors of this Journal.

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ART. XXXII.—*Agricultural Chemistry—Soil-analysis: Notice of the Agricultural Chemistry of the Geological Surveys of Kentucky and Arkansas;** by Prof. S. W. JOHNSON of Yale College.

IN no country has there been so much popular appreciation of practical science as in the United States of America. Scarcely one of the States is without its volume or volumes of Geological and Natural History Reports, and though some of them have been content to confine the work to the merest outline of the general and industrial geology of their territory, and have expended but a few hundreds of dollars in the undertaking, others, like New York, have embraced all the branches of Natural Science in their survey, have prolonged the work of exploration or elaboration through many years, and have devoted money to these objects with unsparing hand.

The results of these surveys as they stand recorded in the numerous volumes published by the States and by the General Government, are of very unequal merit, as might be expected from the wide range of country explored, from the various degrees of interest and appreciation governing the many Legislatures which have authorized these labors and from the exceedingly unequal ability of the individuals charged with their execution.

These explorations have originated in all cases with our scientific men. It is their influence either brought to bear immediately upon the legislative bodies, or exerted less directly through cultivated and public spirited persons to whom the possible benefits of geological surveys have been explained—that has accomplished this vast work.

The enterprises of which we speak being sustained pecuniarily at the expense of the people, and depending from year to year in many cases upon the popular vote, it has been not only politic but right to exhibit at the outset the prospects of pecuniary return for the required outlay of means, as an inducement to support such undertakings. It has been no less proper in presenting the results of the surveys, to lay stress on the discoveries having industrial bearings which are the fruits of the work.

In those States where large quantities of metallic ores occur, the interest of capitalists engaged in mining has often sufficed to inaugurate a geological survey. In other states the agricultural sentiment has had to be operated upon.

Great results have been promised to agriculture from the applications of geology and chemistry, and a great deal of labor has

* 1st, 2d, 3d and 4th Reports of the Geological Survey of Kentucky 1854-60: 2d Report of the Geological Reconnoisance of Arkansas, 1860: Agricultural Chemistry and Geology by Dr. D. D. OWEN, principal Geologist, and Dr. ROBERT PETER, Chemical Assistant.

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been performed in the attempt to satisfy the hopes that have been thus excited.

The chief object of the present notice is to inquire what has been really accomplished for the good of the farmer, by the scientific surveys that have been hitherto prosecuted in this country.

The labors of Dr. Peter in connection with the Kentucky and Arkansas Surveys being the most recent and extended attempts of this kind, we shall make them the basis of our inquiries.

If we except a few pages of general remarks on the theory of vegetable nutrition, &c., which while useful to the practical readers of the Report contain no new facts or principles,—the whole effort of Dr. Peter has been concentrated on the analysis of soils, marls, rocks and ashes. He publishes in the four Kentucky Reports analyses of 375 soils, and in the Arkansas Report, 187, in all 562 soil analyses. Besides, we find the results of examinations of 145 rocks, shales, &c., and of 38 ashes of plants, making a grand total of 795 agricultural analyses.

The agricultural fruits of the surveys of Kentucky and Arkansas are then to be sought in these analyses.

It certainly will strike all that the amount of work performed by Dr. Peter is unusually great. It is now but six years since the Kentucky survey was commenced and in that time the Dr. has not only analyzed 795 soils, but has executed 516 analyses of ores, slags, mineral waters and coals, making an average of two analyses for every three days of this whole period. This labor Dr. Peter states he has accomplished with the help of one intelligent assistant, and by a special organization of his laboratory and his operations whereby the utmost economy of time was secured. We have had such experience of the advantages of a similar system, that we are not prepared to doubt that the chemist who adopts a plan of analysis which fully satisfies him, and from which he never departs, may execute such an amount of work. At the same time we must bear in mind that the only control Dr. Peter offers for the accuracy of his results is, that the sum of the weights of the separated ingredients equals their original conjoined weight, no time being allowed to repeat a determination, or to prove the purity of a precipitate.

The Analytical Process followed in these analyses is not by any means so minute and full as we should be warranted to expect, when their author declares (4th Ky. Rep., p. 57) that "such a work to be eminently useful must be thorough and exhaustive;" for soluble silica, chlorine, nitric acid and ammonia are not at all estimated, and the condition of the iron, whether protoxyd or peroxyd, is not noticed. It is worthy of notice that carbonic acid and lime are always present in atomic proportions in the soils latterly analyzed, no excess of either ingredient being mentioned in the results. Carbonic acid however is not noticed

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in the description of the analytical process, and that figuring in the analyses does not appear to have been directly estimated, but to have come from the oxalic acid of the reagent shelf.

If, as might easily happen, the contrary not being proved, a portion of the lime dissolved by hydrochloric acid exists in these soils as silicate, sulphate or phosphate, then the assumption that it is united to carbonic acid introduces an error into the summing up (which in many cases is exactly 100) and shows that a quantity of some other ingredient has been overlooked.

For the estimation of phosphoric acid a highly modified form of Sonnenschein's process is employed, but our author does not give the figures which prove that his changes are improvements.

Admitting however that the analyses are correct—we next inquire what is their value—what useful deductions from them appear in these Reports.

In the introduction to Vol. i, Kentucky Survey, page 13, Dr. Owen says: "By consulting the numerous interesting results obtained by the chemical analyses of the soils embodied in the pages of this report, abundant evidence will be gathered of the vital necessity of wide dissemination amongst the farming community, of the knowledge to be obtained by a correct insight into their chemical constitution." In the same volume, page 373, Dr. Peter remarks that he was impressed "that when the composition of our Kentucky soils and minerals in general, is once accurately established, their applications to our wants and uses would be obvious to all well informed persons. He has therefore consumed the time mainly in the analyses, and made up his report principally of the results."

In the agricultural section of the Arkansas Survey, p. 47, Dr. Owen says:—"principally from chemical soil-analyses can the agriculturist form an intelligent opinion as to the comparative fertility of soils, and their suitability to the growth of certain plants, as well as judge what applications may be required in the way of lime, bone earth, plaster of Paris, ashes, or salts of potash, soda, &c."

Dr. Peter, in the same volume, page 166–7, observes:—"It is believed that by no other mode than by chemical analysis or by the more tedious and laborious method of actual experience, in cropping for a series of years and publishing a record of the same, can the actual nature, capabilities and value of the various soils of a State be presented to the public; and that by instituting this Geologico-Agricultural Survey, the State of Arkansas not only aids materially in the progress of the general science of the civilized world, and that of the soil in particular, but takes the most effectual mode of making known to the enlightened immigrant her agricultural riches. In this she has followed the wise lead of the older state of Kentucky, in which, since the institution of her geological survey, the value of the land

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in the regions examined and reported on has been very greatly enhanced."

In the Agricultural Geology of Kentucky, Report 2d, p. 9, Dr. Owen says: "Placing implicit reliance on the capabilities of chemical science to indicate by the analyses of soils, the ingredients removed by the cultivation and harvesting of successive crops, it was hoped that by collecting samples of the virgin soil, and of the same soil from an adjacent old field, that not only the different substances assimilated out of the soil could be ascertained, but also the exact proportion of these so that the farmer might know precisely what must be restored to the land to bring back its original fertility."

These quotations sufficiently show what were the opinions which led our author to devote such an amount of labor to the analysis of soils, and indicate in general, what results were expected.

In the 2d Arkansas Report, p. 49 et seq., Dr. Owen "proceeds to explain in what way soil-analysis becomes of value to the farmer." He desires "to call particular attention to this subject, because the opinion has been expressed even in this year (1860), and by those having a high standing in the scientific world, that chemistry is incapable of conveying any useful information to the farmer by analyzing his soil."

On the six following pages of the 2d Ark. Rep., and on page 30 of the 4th Ky. Rep., Dr. Owen gives the most complete *résumé* of the teachings of soil-analysis which we are able to find in the five volumes before us, and as these are his latest writings on the subject, and as he then had the data of 389 analyses, viz. of 187 Arkansas soils and 202 in the three volumes of the Kentucky Report,—these being refrered to on the pages we are quoting from,—we are warranted in considering what he has here presented, as embodying the *strong points* in favor of soil-analysis. We will notice them separately as gathered from both Reports.

1st. "Any one who will take the trouble to inspect the analyses of the 187 Arkansas soils will see that the relative proportions of the eleven mineral constituents of these soils is very accurately given."—*2d Ark. Rep.*, p. 49.

If we admit fully that Dr. Peter's analyses represent with fair accuracy the composition of the two grammes of soil he experimented with in each instance, we do not therefore allow that the composition of "these soils" considered as representing geological formations, or large agricultural districts, or even single fields, is "very accurately given."

Here at the outset the distinguished gentlemen who have conducted the 'geologico-' and 'chemico-agricultural' part of the Kentucky and Arkansas surveys have taken for granted, what being an error, overturns their whole reasoning, and renders their soil-analyses comparatively worthless.

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Years ago, following the teachers of agricultural chemistry in this country and England, we believed that soil-analyses were adapted to be of exceeding use to farmers. Having practised analytical chemistry sufficiently to undertake the work, we proceeded, when on a vacation visit, to collect some farm soils for the purpose of applying our skill and knowledge. On putting down the spade and post-augur into the drift overlying the lowest Silurian of Northern New York, we were at once struck with the difficulty of procuring an average specimen. The soil for a depth varying from two to six inches was quite fine, but below that depth largely mixed with gravel. On comparing different samples taken from a small area, it was plain that the soil was not a fit subject for analysis. The relative quantities of organic matter as indicated by the color of the surface of small stones,—some quartz and granitic, others slate and limestone of several geological members,—were astonishingly variable. Here we found the soil sandy, there it was clay. To take a sample from one place was to do obvious injustice to the sixty-acre field. To take it from a dozen places would not render the selection of a fair sample any more certain. Then as to depth —was it proper to go down six inches, one foot, or how far? Had the field been a bed of iron ore, assays of a dozen samples taken from different parts would have indicated very satisfactorily the general value of the deposit, would have served as data for buying and selling the property, because the worth of an unworked bed of such ore depends less upon its content of iron than upon external circumstances which affect the extracting of the metal. Had the field been covered with rich dressed copper ore to the depth of six inches, it would have been necessary to divide it up into small parcels of a few tons, average these carefully and as carefully assay each one. No one would risk purchasing a hundred thousand tons of copper ore on the analysis of one or of a dozen samples, because it is impracticable to intermix or average such a mass of material as that a dozen samples shall accurately represent it.

We hold it therefore as the first objection to soil-analyses that to procure a specimen which accurately and *certainly* represent a field or district, is practically impossible in the majority of cases, *and if possible, requires a series of analyses to prove the fact.*

This argument applies with the greater force when we consider how small a proportion of the ingredients of a soil are of any immediate use in feeding crops. The really active nutrient matters of a soil are not reckoned by per cents nor by tenths of per cents, but by the minutest fractions.

A heavy crop of thirty-seven bushels of wheat, grain and straw included, removes from an acre of land but 300 lbs. total of mineral matters. According to Dr. Peter's weighings on some

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of the Kentucky soils, we may assume, that taken to the depth of a foot, an acre of soil weighs 3,000,000 lbs. All that is removed by the heaviest wheat crop then in one year is but $\frac{1}{30,000}$, or 0·0033+ per cent.

It follows that the annual removal of the heaviest crop of wheat from a soil for 100 years diminishes its mineral matters by less than 0·4 per cent. If then, in the selection of a sample, the average composition is departed from to the amount of 4 parts in 1000, the analysis may misrepresent the soil, by the value of 3700 bushels of wheat per acre, or by what represents, so far as mineral ingredients can, the fertility of a century.

What freaks and accidents is not the soil-analyst the sport of? A bird, squirrel, or dog relieving nature at the spot where he collects his sample, innocently magnifies the phosphoric acid or alkalies of the surrounding thousand acres a hundred fold. The soil gathered toward the end of a long rain, whereby its soluble matters are carried deep into the subsoil, is declared poor, by analysis, whereas if taken after a fortnight of drought it might appear extraordinarily fertile. Boussingault found in his rich garden soil in June, during wet weather, 0·00034 per cent of nitric acid. In the following September, after a period of dryness, it contained 0·0093 per cent, or twenty-seven times as much as in June. This ingredient is indeed more liable to fluctuation in amount than any other, both because it is formed in the soil, and because it is not subject to the absorbent action which the soil exercises over most other of its soluble constituents; but the same variation occurs among the other ingredients according to the direction of the capillary movement of the soil-water, though in less degree.

Independently however of all considerations and calculations like the above, we have proof—evidence at least that supports these considerations, and has never been publicly refuted—that it is practically impossible to obtain average specimens of the soil. I refer to investigations made as long ago as 1846–9 under the direction of the Prussian "*Landes Oekonomie Collegium*," and reported by the distinguished Magnus. The account of these experiments is given in detail in Erdmann's Journal für Praktische Chemie, vol. xlviii, pp. 447 et seq.

The "*Landes Oekonomie Collegium*" at that time carried on systematic experiments in agriculture at fourteen distinct stations scattered through the Prussian domain. The trials which we now speak of, were made for the ostensible purpose of studying the exhaustion of the soil by cropping. The plan was to analyze the fourteen soils, the history of which for years previous was accurately known, then crop them with rape until "exhausted," then compare together the original composition of the soils with their composition after exhaustion, taking into account as well,

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the composition of the crops removed. The research began with collecting and analyzing the soils. In order to meet as far as possible the difficulties of securing average specimens, equal portions of the soil of each field were taken with the spade at ten or twelve different points, and thoroughly intermixed; each sample was then passed through a sieve, the holes of which were two square lines in area, so as to remove all coarser stones, then again well worked over to complete the mixture. Of each sample three separate portions were analyzed, in most cases by different operators. The analyses were made by, or under the guidance of, the ablest chemists of Germany. They were made according to a prescribed scheme, and that there should be no reason to slight the work, the work was paid for. It is true that analytical chemistry was not so advanced in 1846 as now. It is true that the methods then practised for estimating phosphoric acid and some other substances were not as perfect as they now are; but for the most part the analyses then made are as accurate as any that could be executed to-day. It cannot be supposed for a moment that analysts like Rammelsberg, Bödecker, Genth, Debus, Knop, Heintz, Krocker, Marchand, Weidenbusch, Sonnenschein, Varrentrap, Weber, &c. &c., would by fault of method or by carelessness return anything but results that were accurate, as far as it was possible to make them such. We cannot suppose that their determinations of lime, oxyd of iron, potash and sulphuric acid, substances estimated then by the same methods that are now employed, would vary if they were supplied with homogeneous material to operate upon. But let us look at some of their figures. We tabulate a number of them taken at random:

Soil of		Lime.	Potash.	Sulphuric acid.	Phosphoric acid.
Eldena,	*a.*	0·39	0·93	0·08	0·06
	b.	0·75	2·06	——	0·17
	c.	0·25	0·12	0·02	0·40
Beesdau,	*a.*	0·802	3·825	——	0·042
	b.	0·039	0·490	——	0·046
	c.	0·715	0·792	0·004	0·007
Neuensund,	*a.*	1·692	3·531	0·050	0·051
	b.	0·614	1·289	0·038	0·010
	c.	0·728	1·243	0·241	0·121
Turwe,	*a.*	2·312	1·112	0·040	0·057
	b.	2·67	1·14	0·03	0·20
	c.	3·391	0·201	0·022	0·014
Frankenfelde,	*a.*	0·420	1·155	0·016	0·004
	b.	1·081	——	——	0·418
	c.	0·461	1·456	0·015	0·071

If we run over these figures and those of the entire series of analyses, we find that different determinations disagree to such an extent as to make it the sheerest folly to base any calculation

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of the value of the soil upon analysis. Some of the analyses agree sufficiently to show that accordant results are possible if uniform material be taken; but the grand result of the investigation is that the difficulties of getting a uniform material are exceedingly great. Again, we must remember that in the case before us, the three examinations of each soil were made upon portions of one carefully mixed sample. What would have been the result had each chemist received a sample collected separately from all the others, and from different parts of the field!

Dr. Peter mentions these analyses of the *Landes Collaeium*, and quotes a few of the results on page 187 of the 3d Kentucky Report. He believes however that these discordant results do not invalidate soil analyses when made as they may be made with "means and appliances *now* at the service of the analytical chemist" and thinks "this statement however hazardous it may seem will be found to be sustained" in his Report.

In the Report before us however we do not find anything to sustain Dr. Peter's view. He gives, so far as we have discovered, no duplicate analyses, to show what accuracy his methods admit of on the same sample, much less does he prove by analyses of specimens separately gathered from the same field, that it is easy to procure an average material for analysis. Until this proof is produced the evidence is in favor of our view.

Having shown how small an error in sampling may affect the chemist's estimate of a soil, it is not out of place to insist for a moment, that a similar error in the analysis itself, must have the same result. In running over 200 pages of Dr. Peter's 4th Kentucky Report, we find five analyses of soil in which there is a gain of from five to eight tenths per cent; we find twenty-three in which there is a loss exceeding five tenths per cent. In thirteen of the latter the loss is eight or more tenths, in eight instances the loss is one per cent or more, and in one case is one and eight-tenths per cent. We should scorn to notice little matters like these, errors which are inseparable from the best manipulation and the best processes, were it not that in soil analysis it is precisely the small quantities which alone have any importance.

We find in Dr. Peter's work, as in the work of all who have preceded him in the analysis of soils from Davy and Sprengel down, evidence that the best endeavors in this line of research are entirely incommensurate with the desired results.

It may be objected to this criticism of the analyses that the loss or gain must be distributed among the twelve ingredients determined. It is true that there is a probability that such distribution would be just; but this is by no means *certain*, and it is equally true that this being done there is still force in the criticism—for the four-tenths per cent of the soil which a cen-

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tury of wheat crops would remove, likewise consists of twelve ingredients.

The 2d result of these analyses, according to Drs. Owen and Peter, is what the former (4th Ky. Rep., p. 33) declares to be "a general law" "now established," viz., "that *soil-analysis is capable of showing the exhaustion in land of the mineral food of plants by continual cropping.*"

To show the removal of soil-ingredients by cropping, the plan was followed of collecting soils from contiguous fields, one of which had been "cultivated" while the other was in its virgin state. On comparing the analyses it was found that in seventy-one* cases out of seventy-nine, a loss had occurred in the soil which had been in use without manure from ten to fifty years. In eight instances, however, the analysis failed to show such a result, owing to local causes, the soil of the old field being based on a sub-soil richer than was the virgin field, or the old field having received washings of more elevated lands, &c.

The admitted richness of the old over the new soil in these eight exceptional cases, is expressed by hundredths of per cent, e. g., soil Nos. 982, virgin, and 983, cultivated, differ by 0·066 per cent of potash. Soils 1144 and 1146 by 0·032 per cent of phosphoric acid. Soils 1204 and 1205 by 0·092 per cent phosphoric acid. Soils 1207 and 1208 by 0·033 per cent potash. Similar fractions likewise show the amount of deterioration in the other seventy-one cases. We adduce two instances pointed out by Dr. Peter in the 3d Kentucky Report, p. 207, and one given on p. 176 of the 2d Arkansas Report:

	Carb. of lime.	Magnesia.	Phosphoric acid.	Potash.
Virgin soil, No. 557,	0·345	0·335	0·181†	0·156
Old soil, No. 558,	0·215	0·465	0·103†	0·101
Difference,	0·130	0·130 gain.	0·078†	0·055
Virgin soil, No. 738,	0·180	0·444	0·179	0·256
Old field, No. 739,	0·145	0·388	0·163	0·179
Difference,	0·035	0·056	0·016	0·077
Virgin soil, No. 288,	0·121	0·371	0·127	0·116
Old field, No. 289,	0·021	0·371	0·053	0·097
Difference,	0·100	0·000	0·074	0·019

We were prepared to find these differences much larger. It is seen at a glance that they fall within the errors of Dr. Peter's own manipulation, and when we assert that of ten analyses of the most homogeneous material made by the same analyst under the most favorable circumstances, five would differ among each other by an amount equal to the quantities upon which this "natural law" is supported, we assert what every competent

* Misprinted *twenty*-one, on p. 31, 4th Kentucky Report.

† Misprinted on p. 207, 3d Ky. Rep., where the difference is made 0·045 instead of 0·078, as given above from the tabulated analyses.

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analyst knows to be true, and what moreover pronounces most emphatically upon the value of such investigations.

It is therefore our conclusion, that while, as has long been known, the soil loses in mineral matter what the crop gains, it is doubtful if in any given case chemical analysis can indicate this difference with certainty, for the reasons that the accidents which affect analysis make the limits of inaccuracy, to cover more than the loss by years of cropping. When we take into account the changes that are constantly progressing in the soil when under cultivation—changes by which the disintegration is hastened, changes by which it is made in many instances more retentive of soluble matters—when we remember that most cultivated crops, although they carry off in seed, stem and foliage a quantity of mineral matters, yet derive these in part from a depth below the range of analysis, and in their roots or stubble, leave upon the surface, salts brought up from a considerable depth—we perceive that the problem is so complicated with compensations and variable quantities as to put it beyond the reach of quantitative chemical analysis.

If, in any case, soil-analysis does show or appear to show the exhaustion of the soil, it is however, the appeal to experience which *proves* it, and as this is the first, most obvious, and an entirely sufficient proof, we do not see the value of the "law" that has 10 per cent (eight-seventy-ninths) of exceptions, the existence of which like that of the rule itself, is only to be established by comparison with the plain agricultural fact.

In short, if we admit the result as Drs. Owen and Peter would have it—of what use or interest is it?

The 3d point, is that analysis shows "the peculiarities of the soils derived from different geological formations." Says Dr. Owen, "these analyses most distinctly show that certain geological formations impart to the soil more of the important mineral fertilizers than others." The reader will be able "to see that it is those formations which are composed of easily disintegrating materials, which, all other things being equal, yield the soils richest in phosphoric acid, lime and potash; and at the same time contain the quantity of alumina and oxyd of iron necessary to render them sufficiently retentive and attractive of atmospheric water and ammonia; therefore these soils are the best adapted for those grains and crops which require the largest proportion of these ingredients." "He will moreover be able to trace the gradual diminution in the proportion of the more important mineral ingredients, down from these extraordinarily fertile soils derived from the highly fossiliferous, argillo-calcareous beds of the lower Silurian, the Cretaceous and the Tertiary systems of the West; through the silico-calcareous soils of the upper Silurian, Devonian and Sub-Carboniferous limestone strata, in which fossils are either more sparingly distributed or, in some

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cases almost wanting, and which are far less easy of decomposition; thence through the argillo-silicious soils of the Coal measures with only locally organic remains, and these chiefly of plants, down to the more purely silicious soils prevalent where the non-fossiliferous sandstones of the Coal measures and of the Millstone Grit, prevail to the exclusion of either shales or limestones and which afford the most unproductive soils as yet analyzed." While it is to be expected that rocks of complex origin rich in organic remains—which are evidences that the rocks themselves originally resulted from the deposition of the washings of fertile lands—should yield richer soils than sandstones or limestones, we do not see that analysis of the soil makes the fact more evident Knowledge of the composition of a rock enables us to judge in a general way of the value of the soil, so far as this depends upon chemical characters. We do not see what is gained by further analyses of the soil. It would appear that the cheap mental processes of deduction or inference may accomplish here in a moment all that an expensive analysis can show.

We fail moreover to perceive that analysis shows "the *peculiarities* of the soils derived from the different geological formations." In a cretaceous or limestone soil we of course expect to find much carbonate of lime, and in a sandstone or millstone grit soil much insoluble silica or silicates, but the quantities of phosphoric acid, potash and sulphuric acid do not appear to bear any definite relation to their geological origin. It is impossible to represent the composition of the soil of any geological formation by a typical statement of percentages, or to point out its peculiarities further than by an undefinable more or less. Although Kentucky and Arkansas lie mostly or altogether beyond the influence of drift, yet the action of running water in its constant passage from hill-top to valley has to a great degree obliterated from the soils those *peculiar* differences to be found among the rocks from which they have been derived.

A careful examination of the analyses recorded in the Arkansas survey shows that the average composition of the eight soils analyzed from the Lower Silurian and of the fourteen from the millstone grit, compare as follows, in regard to the more important ingredients:

	Carb. lime.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.
Lower Silurian, average of 8 soils,	0·533	0·485	0·184	0·052	0·355
Millstone grit, " 14 "	0·215	0·531	0·180	0·057	0·148

Here we see that the soils of the poorest formation are inferior to those of the richest only in carbonate of lime and potash. Of the soils of the millstone grit, nine are richer in carb. lime than the poorest of the Silurian, and five of the former contain more potash than the poorest of the latter. On the other hand but two of the Silurian soils have higher percentages of either carb.

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lime or potash, than the richest soil of the millstone grit. If these figures demonstrate anything, it is the fact, that no geological formation has the absolute monopoly of either barren or fertile soils. If the analyses of Dr. Peter show the "peculiarities" of the soils of any geological age, then certainly these peculiarities are not remarkably peculiar!

On page 50 of the 2d Ark. Rep., Dr. Owen remarks as follows:

"With the table of the composition of the ashes of plants to refer to, appended to this Report, and after becoming acquainted with the usual proportions of mineral constituents in an average soil, information which is easily acquired by looking over the table of soil analyses in this Report, it is easy for any individual to see, when he is provided with a reliable analysis of his soil, not only to what crop it is best adapted, but what kind of mineral fertilizers, if any, it requires as a manure, and how it compares in fertility to the various grades of soils from other farms and other states. Is not this knowledge of some value to the farmer?"

The above, we are of opinion, proceeded rather from the generous heart than from the critical brain of its lamented author. Had he attempted to *do* the things which he believed to be so easy, we are sure his statements would have lost somewhat of their directness and would have appeared in a form highly modified from the above. "The usual proportion of ingredients in an average soil." What is an average soil? Our only way of deciding what is such a soil consists in noting the average yield of soils. But the yield depends not alone on the soil, but upon climate, weather, tillage and various incidents and accidents. It depends not on the composition of the soil—not on the "proportion of ingredients" alone, but likewise on the condition of those ingredients, their state of combination, their solubility. It depends also on the physical characters of the soil, which determine the relations of the crop to the essential conditions of regulated heat and moisture. The soil is not less important to the plant in its function of home than in its function of food, the lodgings are of equal influence with the board. It is a nice work to balance these varying circumstances, many of which have as yet in our science, no shadow of a numerical expression, and then to say how many thousandths of a per cent of potash, lime, phosphoric acid, &c., belong to the "average soil."

Dr. Peter has indeed attempted to show the degree of availability of the elements of the soil by the following process. "A quantity, generally thirty grammes of the air-dried soil is placed in an eight-ounce strong vial, with a close fitting stopper, and the bottle is filled up with distilled water which has been charged with pure carbonic acid gas, under a pressure of about two atmospheres. The bottle is allowed to remain for about a

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month at a temperature about that of summer heat." The matters thus dissolved were then analyzed as usual. These results have this value, they show that the water of the soil is capable of dissolving all the elements of the food of plants. They furnish moreover a *rough* comparative view of the available matters in different soils. Beyond this we cannot attach any value to them.

We now come to Dr. Owen's 4th result of soil-analyses, embodied in the above quotation, and repeated on p. 30 of the 4th Ky. Rep., viz: its power of indicating "the suitability of the soil for any particular crop." Closely related to this is the 5th item, viz., that analysis can show "what addition any soil, either uncultivated or cultivated, requires to render it productive and remunerative for any given crop; and, of course, the deficiency in the soil of one or more of the eleven elements determined by chemical analysis."

We cannot help feeling that the above assertions which are here made unqualifiedly, were intended to be understood with a large amount of reserve and subject to various conditions. Otherwise we must regard them quite unjustified, if not absurd. The chemical analysis of soil reveals nothing as to its tenacity or lightness, its porosity or retentiveness for water, yet these physical and mechanical conditions more than anything else determine the adaptation of a soil for any particular crop. The best grass lands are not the best wheat lands—and although it would scarcely be questioned that wheat requires a richer soil than grass in order to produce an average crop, and although as we know, it often happens that many successive hay crops may be removed from a meadow without sensible diminution of the yield, while uninterrupted cropping with wheat nearly always reduces the capacity of the soil in a very few years below a profitable point; yet each average hay crop removes from a field more of every ingredient of vegetation than the grain and straw together of an average harvest of wheat.

Such at least is the testimony borne by the most recent and trustworthy data. Dr. Anderson of Glasgow basing his calculations on the best analyses and on the extensive agricultural statistics gathered in late years by the Highland and Ag. Society of Scotland, makes the following estimate of the amount of the principal ingredients removed from an acre by average crops of seven staple British farm products. See table on next page.—*Trans. Highland and Ag. Soc.*, 1861, p. 568.

On comparing the amount of matters removed from an acre by the wheat and hay crops, we find that the latter requires four times as much potash, lime and sulphuric acid; twice as much silica and one-fifth more nitrogen.

Again we know that oats are raised on soils which are considered too poor for the profitable production of wheat, and the

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	Produce per Imperial Acre.	Total Weight in lbs.	Total Mineral Matters.	Potash.	Soda.	Lime.	Magnesia.	Chlorine.	Sulphuric acid.	Phosphoric acid.	Silica.	Nitrogen.
Wheat—												
Grain, ...	28 bush. at 60 lb.	1680	34·12	10·11	1·20	1·04	4·80		0·32	16·22	0·43	29·20
Straw, ...	1 ton, 3 cwt.	2576	114·48	20·70	2·84	8·53	2·23		3·55	3·16	73·47	16·13
Total, ...			148·60	30·81	4·04	9·57	7·03		3·87	19·38	73·90	45·33
Barley—												
Grain, ...	33 bush. at 53 lb.	1749	44·24	9·40	0·30	0·76	3·10	1·12	0·85	15·52	13·19	34·98
Straw, ...	18 cwt.	2016	99·14	11·24	1·14	5·81	2·75	1·30	1·10	7·22	68·58	6·03
Total, ...			143·38	20·64	1·44	6·57	5·85	2·42	1·95	22·74	81·77	41·01
Oats—												
Grain, ...	34 bush. at 40 lb.	1360	48·89	11·00		5·31	4·04	0·20		26·07	2·27	27·54
Straw, ...	1 ton.	2240	143·53	30·71	6·10	10·29	5·50	5·55	5·18	7·35	72·85	14·10
Total, ...			192·42	41·71	6·10	15·60	9·54	5·75	5·18	33·42	75·12	41·64
Beans and Peas—												
Grain, ...	25 bush. at 60 lb.	1650	55·97	30·00	0·31	3·01	4·00		1·76	16·65	0·24	46·10
Straw, ...	1 ton.	2240	108·51	48·61	13·14	29·37	3·74	7·00	2·07	0·74	3·84	26·88
Total, ...			164·48	78·61	13·45	32·38	7·74	7·00	3·83	17·39	4·08	72·98
Turnips, ...	13½ tons.	30,240	213·75	57·35	44·71	28·60	4·65	10·35	39·02	22·57	6·50	60·48
Potatoes, ...	3 tons.	6720	55·58	28·92	2·85	1·20	2·11	3·21	10·24	5·76	1·29	26·00
Hay, ...	2½ tons.	5600	391·31	129·79	4·80	35·46	9·62	39·61	16·57	21·79	133·67	56·22

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table shows us that an average crop of oats requires more of every mineral ingredient than is needful for a corresponding wheat crop.

In fact, wheat is the crop, to grow which continuously requires, according to universal agricultural experience, land richer than that needed for any other of the seven crops whose chemical statistics are given in Dr. Anderson's Table, and notwithstanding, with exception of barley and the potato-tuber, it removes the least from the soil.

The farmer knows that wheat delights in a deep, rather heavy soil, one which holds moisture well, and yet is not wet. Barley and oats flourish on soils that are too dry and light, and grass on those which are too wet for wheat.

But how does the matter stand when these external conditions are taken into account? Does not analysis aid us then in a good degree? Let us take a case similar to what has repeatedly occurred in actual practice. We have a soil which as the result of long cultivation or from natural deficiencies, is incapable of yielding a remunerative crop of wheat. Its texture is good, it has produced wheat abundantly, and needs nothing but a little of the right kind of manure to restore its power of giving a crop. We put upon it Peruvian guano at the rate of 300 lbs. per acre, and the harvest is a good one. The entire addition to the soil is but $\frac{300}{33000}$ths = one hundredth per cent. The amounts of phosphoric acid, of alkaline earths and nitrogen added, are for each, but one six-hundredth per cent of the soil, taken to the depth of a foot. These quantities are rather minute for even the improved analysis of the present time to estimate successfully.

Calculations like this show that the chemist cannot discriminate by his analysis between; 1st, a soil which is unproductive from the temporary exhaustion of some of its available ingredients; 2d, the same soil which is rendered fertile again for a year by the use of 300 lbs. of guano; and 3d, the same, made over-rich so that nothing will grow on it, by an application of a ton of guano.

On page 18 of the 2d Ky. Rep., Dr. Owen remarks as follows: "During last summer a soil was collected in Bullit county, from an old field which had been fifty or sixty years in cultivation, and which will now no longer produce clover. I venture to predict that when the analysis of this soil shall be completed it will be found to be deficient in some of these constituents,* and the analysis will probably show what other green crop might succeed better for the renovation of such land."

On page 230 of the 3d Ky. Rep., Dr. Peter gives the analysis of this soil, and says, "The inability of this soil to produce clover

* The mineral ingredients of plants.

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is explained by its very small proportion of lime, and rather small amount of sulphuric and phosphoric acids. The addition of plaster of Paris or some of the calcareous marls would probably restore it to the capability of supporting a clover crop."

The percentages of the ingredients which Dr. Peter considers deficient, are as follows:

Carbonate of lime, - - -	0·072 = lime 0·040
Sulphuric acid, - - -	0·055
Phosphoric acid, - - -	0·070

Small as are these quantities, the smallest of them, viz., that of lime, yet amounts to 1200 lbs. per acre, which is enough to supply 10 clover crops of 3 tons each, and as by the analysis it all exists in the form of carbonate, it must all be available. We know from the vegetation experiments of Boussingault, Ville, and Sachs, that plants are capable of absorbing from a limited amount of soil *the whole* of any soluble nutritive substance present, provided its quantity be no more than the plants require, and the other elements of fertility are at hand in excess.

Twelve or thirteen years ago, Dr. Anderson in his capacity of Chemist to the Highland and Ag. Society of Scotland, had occasion to investigate two soils which had become "clover-sick," and he caused them, together with similar adjacent soils which still produced clover, to be most minutely analyzed. Without reproducing his figures, which may be found in the Trans. of the Highland and Ag. Soc. for 1849–51, p. 204, we will merely quote some of the remarks which accompany the analyses: "The results of these analyses are certainly of an unexpected character, and appear to me to indicate that, in this instance the failure of the clover cannot have been dependent upon the chemical constitution of the soil. In both cases the results of the analyses of each pair do not present a greater difference than would be obtained from the analyses of two portions of soil from different parts of any field."

In the present year, Stoeckhardt (*Chemischer Ackersmann*, No. 2, 1861, p. 85), has published an account of several "clover-sick" soils from Schlanstaedt, which reveal to analysis a greater content of *every nutritive mineral ingredient* both soluble in water and in acids, than exists in another soil from Frankenstein which produces clover and wheat as well. What proves beyond a doubt that the inability of these soils to yield clover depends upon something besides their chemical constitution, is the fact that lucerne and esparsette still flourish upon them admirably, and further, clover itself, if sown with one of these last mentioned crops, succeeds very well.

A great truth in agriculture is this: Each kind of agricultural plant requires that its seeds be surrounded with certain conditions in order that they may germinate readily and healthfully, so

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that when the mother cotyledons are exhausted, the young plants shall attack the stores of food in the soil with that vigor which is needful in order to appropriate them without hindrance.

The fact that winter wheat is more delicate and fastidious in its infancy than most other crops, is perhaps the main reason why it does not succeed well on many good lands, and why it cannot be continuously produced from the same soil, year after year. It is a matter of experience that wheat requires a rather firm seed-bed: beans, oats and mangold-wurzel approach wheat in their requirements, while barley, peas and turnips are best suited in a light tilth. On the other hand, climate, weather and tillage so influence the character of the soil, that even on light lands, wheat may find all the conditions of its growth. The bed which is produced by inverting a clover sod, and allowing it to consolidate by time and rains, or by passing a heavy roller over it, is eminently adapted to wheat, even on a rather light soil.

The fact that in the cases given above from Stoeckhardt, clover succeeded when sown with lucerne or esparsette, would indicate that, possibly, the condition of the seed-bed was the cause of failure.

These and other facts which might be adduced to almost any extent, indicate sufficiently that chemical analysis alone, even if we admit its full nicety and accuracy, can at the best furnish us with a knowledge of but a few of many conditions which must coöperate in profitable agricultural production, and as a consequence, its part in guiding the farmer is but very subordinate. Taking into the account its evident uncertainty and clumsiness when applied to estimating the minute quantities which affect vegetable growth, the part it can play becomes still more subordinate—we hesitate not to say, insignificant.

As we write, a fragment from a Scientific Journal brings to our notice a discovery which if real, strengthens our views in an unexpected manner. It is well known that iodine is so immensely diluted in sea-water—the soil of marine-plants—that none of our tests though they are among the most delicate, serve to detect it directly, and it is doubtful if it has been detected even in the highly concentrated mother liquors which remain after separating the crystallizable salts, yet the fuci find and accumulate it, and we must grant that it is present there for them, in sufficient quantity.

Again, Prince Salm Horstmar several years since, in his admirable researches on the influence of the individual mineral ingredients of plants on the development of oats and barley, found that he could not by any possibility exclude chlorine from his experimental plants. His soils and pots, the salts and water he fed his plants with were so purified that he could not detect this element in them, and yet he invariably discovered it in the

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ashes of the plants. So too he found titanic acid in the produce grown on the most carefully purified soils. Now, it is mentioned in the "Chemical News" that he finds *a few hundredths of lithium are indispensable* to the ripening of barley. This element Bunsen has but recently shown to be everywhere distributed, yet it has been hitherto entirely unnoticed in all soil- and plant-analyses because of its occurrence in almost infinitesimal quantity.

It must be well borne in mind that Agriculture herself—so-called Practice—is able of her own resources to judge somewhat of the value of soils, is able to know if a soil be fertile or poor, is able to pronounce upon its adaptation to crops, and can to a certain extent decide what is a good manure for this or that field.

We are free to assert that the knowledge which is now to be gathered from experience, is able in ninety-nine cases out of one hundred, to give a more truthful verdict as to the capacity of a soil, that any amount of analysis, chemical, mechanical or otherwise, can do. We would give more for the opinion of an old intelligent farmer than for that of the most skilled chemist in most questions connected with farming. Doubtless the farmer would make some blunders from which chemistry might save him, but the chemist would be likely to do more violence to agriculture, than the farmer would to chemistry.

By these statements which may, but should not surprise some of our scientific friends, we merely intend to express an opinion as to the present relative position towards agriculture of those who regard the art from a chemical, and those who see it from an experimental point of view.

If any one has fuller and more inspiring notions of the importance of science in its applications to agriculture than we have, we desire to sit at his feet and share the higher *afflatus*. But our inspiration, if it be of the sort that works enduring benefit, must be based on clear ideas of the directions in which advance is possible and on a full perception of the difficulties that lie before us, and the means of overcoming them.

We have great faith that chemistry and that chemical analysis have done and are to do a work for agriculture, that shall lay that venerable art under everlasting obligations to the youthful science. But not by soil-analyses alone or mainly is this to be achieved. We do not assert that soil-analysis is worthless—we believe that the probabilities of its uselessness in direct application to practice are so great that we would rarely base any operations on it alone, and yet it may in many cases, promote science and give us data for conclusions that are of practical use. But for these purposes it must form part of a system of observations and trials, must be a step in some research, must stand not as the index to a barren fact, but as the revelator of fruitful ideas.

We hold that soil-analysis long ago played out the part which Dr. Peter would have it perform. In the hands of Sprengel it

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was fertile with new truth, but it must henceforth be a tool for occasional use, and not an engine of discovery. With our advance in knowledge there must be an advance in methods of finding out the unknown. Soil-analysis was indeed a means of insight into the secrets of vegetable growth, but it carried with it the measure of its limit. What we call telescopes do not enable us to see *the end!*

To study the soil in the hope of benefitting agriculture, we must regard all its relations to the plant. We must examine it not merely from those points of view which theoretical chemistry suggests, but especially from those which a knowledge of practical agriculture furnishes. This is becoming more and more the habit of agricultural chemists and the results are of the happiest kind.

Let us remember what the illustrious Nestor of Agricultural Science, Boussingault, has said as the summing up of his protracted experience and study.

"At an epoch not far distant it was believed that a strict connexion existed between the composition and the quality of arable soil. Numerous analyses shortly modified this opinion as too positive. The sagacious Schübler even sought to prove in a research that has become classic, that the fertility of a soil depends more upon its physical properties, its state of aggregation, power of absorption, &c., than upon its chemical constitution."

"The physical properties, in my opinion, do not enable us, more than the chemical composition, to pronounce upon the degree of fertility of the soil. To decide this point with some measure of certainty, it is indispensable to have recourse to direct observation; it is necessary to cultivate a plant in the soil, and ascertain with what vigor it developes there: the analysis of the plant afterward intervenes usefully, to indicate the kind and quantity of the elements that have been assimilated."—("*De la Terre Végétale considerée dans ses Effets sur la Vegetation*," page 283 of "*Agronomie, Chimie agricole et Physiologie, Tome premier*, 1860.")

There has been much progress made in our knowledge of the soil during the last ten years. This advance has not consisted in revealing to us the presence of new elements (lithia perhaps excepted), nor in fixing with any more certainty the quantitative limits which separate barrenness from fertility, it has not shown what is the composition of a Silurian or a Sub-Carboniferous, a Drift or a Tertiary soil, it has not defined the soil adapted to wheat or that productive of clover, it has not indicated the manures which this or that soil needs; but content with the fact that all soils which naturally support vegetation contain the elements of vegetation, it has sought to ascertain in what forms these elements are assimilable, how they may be made available, what changes or reactions in the soil affect its productiveness; how fertilizers act indirectly (their influence often having no

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relation to any supposable direct action), how the soil affects the life of the plant otherwise than by feeding it, &c. &c.

We are approaching in fact by slow degrees to an understanding of the physiological significance of the soil, a grand result to which chemistry and physics coöperate.

We trust that in the future, the American people will not less but more appreciate the value of science in its practical and especially its agricultural bearings; that here, as in Germany, France and England, the labors of those who seek to unite Practice with Science may be fostered and sustained. But to this end scientific men must be cautious that in endeavoring to help, however honestly and laboriously they may work, they do not hinder.

Sheffield Scientific School, August 20th, 1861.

Art. XXIII.—*The Great Comet of* 1861.*

1. *Observations at New Haven.*

On Sunday evening June 30th between 8 and 9 o'clock, there was observed at New Haven, in the northern part of the heavens in an opening between the clouds, and at an elevation of about ten degrees, a nebulous body of unusual brilliancy. Its appearance was similar to that of the planet Jupiter shining through a thin mist; and it was nearly as conspicuous an object in the heavens as Jupiter, although this was due not wholly to the intensity of its light, but partly to its extent of surface, its apparent diameter being about equal to that of the full moon. It was at once suspected that this body was a comet; but this conclusion was adopted with some reserve, on account of the unusual brilliancy and sudden apparition of the meteor. This light was soon concealed by a cloud; but about half an hour later, a larger opening in the clouds disclosed the tail of the comet, in the form of a bright streamer, with sides nearly straight and parallel, and pretty sharply defined. The head of the comet was now invisible; but a little later, both head and tail were seen simultaneously, forming together one of the most brilliant comets of the last fifty years, and astonishing every one by the suddenness of its development. Mr. R. W. Wright of this city marked the position of the comet's head upon a star chart as accurately as he was able, and hence concludes that about a quarter before nine o'clock, June 30, its R. A. was 108° and Dec. 47° N.

On Monday it was ascertained that on Saturday evening, several individuals had noticed in the north a bright streamer rising to a great height above the horizon, and it was at once concluded

* The first part of this paper was published in advance of this issue, July 20th. We now reproduce it with important additions.—Eds.

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that this was the tail of the same comet. The daily newspapers report that the head of the comet was seen on Saturday evening at Columbus, in Ohio, but it is not known that any one made any accurate determination of its place.

On Monday night at New Haven the sky was overcast; but on Tuesday evening July 2d, the sky was mostly clear, and the comet very conspicuous; although it was thought that its head was not as brilliant as it had been on Sunday evening. At $9^h\ 31^m$ P. M., the position of the head was in R. A. $8^h\ 41^m$, and Dec. 63° 5′ N. Seen through a telescope of five inches aperture, with a power of 55, the head was fully thirty minutes in diameter. Near the center of the nebulosity appeared a very brilliant nucleus, from which emanated a luminous sector, whose opening was about 90°, one side being nearly vertical and the other or right side was nearly horizontal. This brush of light extended two minutes from the nucleus. The tail of the comet could be traced to a distance of 90° from the head.

On Wednesday evening the sky was again clear, and the comet was observed to great advantage, but its brilliancy had palpably declined since Sunday evening. At $9^h\ 5^m$ P. M., its head was in R. A. $9^h\ 52^m$ and Dec. 66° 10′ N. Seen through the telescope, the coma had about the same extent as on the preceding evening, but the luminous sector already mentioned, had changed very noticeably. The sides of the sector were curved, the concavity being outwards, and the opening of the sector amounted to 136° when measured to the extremities of its arc, but the initial directions of the two sides formed an angle at the nucleus of about 90°. From the nucleus to the edge of the sector was 1′ 34″. Beyond this, there was a dark arch or band concentric with the nucleus, and beyond the dark band a luminous arch or envelope faint and misty, the middle line of which was 2′ 56″ from the nucleus. Beyond this there were faint indications of a second envelope, with an intervening dark arch, the whole forming a series of nearly concentric light and dark arches, similar to those observed in Donati's comet in 1858, and in Halley's comet in 1835. The tail of the comet on Wednesday evening could be traced through an arc of 95°, and the deviation of its axis from the position of direct opposition to the sun was about 12°, and toward the east, the axis produced cutting the ecliptic about 8° behind the sun's place.

The tail of the comet was carefully observed on several clear evenings, but the observations were more detailed and complete on the evening of July 3d. The northern edge grazed the star Lambda Draconis, passed about 15′ to the south of Kappa Draconis, and continued on through Iota Draconis, and far beyond it, in an arc of a great circle. The southern edge passed just to the north of H. 32, Ursae Majoris, grazed H. 30, Ursae Majoris, and continued on through the stars 3 and 8 Draconis. (Accord-

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ing to the B. A. Catalogue these stars are Nos. 3496, 3358, 3968, and 4347.)

It broke off, or suddenly became faint, before it reached the distance of Alpha Draconis, at about 20° from the nucleus. From that point the tail continued as a much fainter milky band, decreasing very gradually in luminosity, and varying but little in apparent breadth. This breadth was less than one-half the breadth of the extremity of the brighter portion, which was about 3°. The southern edge of the narrower and fainter stream passed through Alpha Draconis, and grazed the stars Tau, Sigma, and Eta Herculis. The decreasing light of this stream vanished in the immediate vicinity of the Milky Way, to the east of β Ophiuchi. The extreme length of the tail was about 95°. The train of the comet was apparently made up of two distinct streams of luminous matter, differing greatly in width and length. The northern edges of the two were in the same line, but the extreme breadth of the shorter stream was much greater than that of the other. Its southern edge was badly defined, and somewhat concave outward. A very faint diffused light, rapidly widening out, could be traced far beyond the point where the sudden falling off of brightness occurred. This diffused light extended, on the evenings of July 4th and 5th, to the vicinity of Corona Borealis, or more than 40° from the nucleus, and attained to a width of 12° or 15°. Its southern edge passed just to the north of the star Theta Bootis. The breadth of the tail, as distinctly seen, at its broadest part, was about 3°. On the evening of June 30th, the estimated breadth was 5°; but a faint light on the south side was traced 5° farther, giving an extreme breadth of 10°. On July 4th, the tail was visibly forked about 2° below the star Alpha Draconis, or 15½° from the nucleus. On the following evening the point of forking was 3° or 4° above the same star. The nucleus had advanced 5½° toward it in the interval.

It was also observed, on the evening of July 4th, that by examining carefully it could be discerned that the long narrow stream increased in breadth about in proportion to the distance from the nucleus. At the point where first seen as a distinct stream its breadth was about 1½°.

Since July 5th the tail of the comet has decreased, from night to night, in brightness, as well as in length and breadth.

2. *Observations at Washington.*

The following places of the comet as observed at the U. S. Naval Observatory, Washington, have been communicated by Lieut. J. M. Gilliss, Superintendent of the Observatory. The observations were made by Mr. Ferguson with the large equatorial.

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M. T. Washington.	No. of comp.	α	δ
1861, July 2, $9^h\ 55^m\ 19^s{\cdot}3$	10	$8^h\ 43^m\ 6^s{\cdot}97$	$+63°\ 12'\ 14''{\cdot}7$
3 $8\ 46\ 46{\cdot}3$	2	$9\ 51\ 41{\cdot}15$	$66\ 9\ 52{\cdot}5$
3 $9\ 10\ 7{\cdot}3$	5	$9\ 52\ 52{\cdot}55$	$66\ 11\ 6{\cdot}0$
4 $8\ 51\ 20{\cdot}5$	12	$10\ 58\ 36{\cdot}26$	$66\ 54\ 20{\cdot}6$
6 $9\ 0\ 52{\cdot}5$	4	$12\ 31\ 12{\cdot}57$	$64\ 51\ 7{\cdot}6$

On the night of the 3d, it was observed on the meridian with the transit instrument by Prof. Robinson, U. S. N. and with the mural circle by Prof. Hubbard.

M. T. Washington.	α	δ
July 3 $15^h\ 21^m\ 46^s{\cdot}7$	$10^h\ 11^m\ 7^s.25$	$66°\ 33'\ 31''{\cdot}5$

From the observations of the 2d, 4th and 6th, the following elements of its orbit were computed by Prof. Hubbard.

Perihelion passage 1861. June 11.43955.	Washington mean time.	
Longitude of the perihelion,	$249°\ 11'\ 28''{\cdot}4$	Mean eqx.
Longitude of ascending node,	$278\ 58\ 32\ {\cdot}1$	1861·0
Inclination of the orbit,	$85\ 37\ 35\ {\cdot}5$	
Perihelion distance,	0·821531	
	Motion direct.	

These elements give for the middle observation

$$\Delta l = -15''{\cdot}7\ (c-o)$$
$$\Delta b = -10\ {\cdot}6$$

It is obvious from these elements, that this comet is not the same as the comet of 1556 (called Charles Vth's comet) whose return has been anticipated for several years; nor do these elements bear any resemblance to those of any comet in the published catalogues. We must conclude then that this comet is a new one, whose orbit has never before been computed.*

3. *The Comet, as seen at the Observatory of Harvard College, Cambridge, Mass.* Communicated by G. P. Bond, Director.

The comet was first seen at the Observatory of Harvard College in the early twilight on the evening of Tuesday, July 2d. The sky was clouded on the first and on the thirtieth. On Saturday the twenty-ninth of June the air was hazy preventing the usual sweeping for comets, although observations near the meridian were prosecuted until about 11^h P. M. Had the sky been clear, the tail of the comet would probably have been seen. A day or two previous, the western twilight had been explored with an opera glass, but at this time only the upper part of the tail could have been in sight, and it must have been too faint to attract notice.

The condition of the theory of cometary formation makes it very desirable that astronomers should devote more attention than they have hitherto been accustomed to do, to the accurate

* We have received from Lt. Gilliss a paper on the physical characters of this comet, which will appear in November. Prof. Hubbard's latest computations however are given on p. 265.

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delineation of the curve of the tail among the stars. The present opportunity has been improved at the Observatory of Harvard College by making careful tracings of the boundaries of the rays through their entire extent upon star charts. The *Uranometria Nova* of Argelander was found to be especially convenient for the purpose, both from the exactness of the projection and the care taken in giving the proper magnitudes to the stars which greatly facilitates their identification. An uninterrupted series of clear nights from the second of July to the present time has very much favored us in preserving the continuity of the phenomena, which is a condition of the utmost importance for their future discussion.

The suddenness of the apparition of the comet in northern latitudes was one of the most impressive of its characteristics. On the 2d of July after the twilight had disappeared, the head, to the naked eye, was much brighter than a star of the first magnitude, if only the effective impression be taken into account, although as to intensity it was far inferior to α Lyræ, or even to α Ursæ Majoris. I should describe the head as nearly equal in brightness to that of the great comet of 1858 between the 30th of September and the 5th of October; it should be considered however that the present comet was better situated, from its higher position above the horizon at the end of twilight.

The aspect of the tail suggested a resemblance to the comet of March, 1843. It was a narrow, straight ray projected to a distance of one hundred and six degrees (106°) from the nucleus, being easily distinguishable quite up to the borders of the milky way. The boundaries for the most part were well defined and easily traced among the stars. It was not until after two or three hours of observation, that I could gain a clear comprehension of the structure of the tail or tails as they presented themselves to the naked eye and through a small opera glass. It was then evident that a diffuse, dim light with very uncertain outlines, apparently composed of hazy filaments, swept off in a strong curve towards the stars in the tail of Ursa Major—the southern edge directed as low as towards Mizar. This was evidently a broad curved tail, intersected on its curved side at the distance of a few degrees from the nucleus by the long straight ray which at the first glance, from its greatly superior brightness, seemed alone to constitute the tail. The two were in fact counterparts of the principal tail and the supplementary rays of the great comet of 1858, with this remarkable difference, that in the latter the straight rays were so far inferior in brightness to the curved tail as to have been recognized at only three observatories, those of Poulkova, Göttingen and Cambridge, U. S.—while with the present comet, the predominating feature was the straight ray to which the curved tail seemed scarcely more than a wisp-like appendage.

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On further scrutiny with the aid of an opera-glass, two sharply cut and very narrow dark channels, bounding the principal ray, could be traced for ten or fifteen degrees from the nucleus; while outside of them, on either side, were two additional faint rays. The whole issue of nebulous matter from the nucleus far into the tail was curiously grooved and striated. It was noticed that both the principal ray and the dark channels penetrated within the outline of the curved tail, the latter being clearly separated from the principal ray even to the naked eye by a dark cleft just above their intersection. The well defined margin of the principal ray admitted of a very exact delineation, even as far as α Ophiuchi, 100° from its origin.

On the third, the bright rays and dark channels were traced to a distance of 40° from the nucleus, the principal ray to nearly 100°. Five or six alternations were distinguished, besides the hazy filaments constituting the curved tail. Some of the streaks could be traced quite up to the nucleus. The rays were not only separated by the dark channel parallel to their axes, but they were disconnected at intervals in the direction of their length.

On the fourth, there were two or more regions of contrary flexure on the north following margin of the ray, which, in a theoretical point of view, are of very great interest when taken in connection with the direction of the ray almost precisely in a great circle from the sun continued through the nucleus. This peculiarity presented itself still more decisively on the fifth, when the tortuous path of the ray could not be overlooked.

The very singular aspect of the northern edge of the principal ray for the first thirty or forty degrees of its course, attracted particular attention, and the charts were revised with all possible care. The sky was perfectly clear and the outlines so distinct that there could be no room for doubt as to the reality of the reflexure of the curve. Subsequently on projecting an arc of a great circle from the sun through the nucleus, it was found to lie clearly within the margin of the ray as far as a distance of thirty degrees (30°), from the nucleus, and there was still haziness beyond it almost to the distance of sixty degrees (60°). The charts on other dates indicate similar results, but the data cannot be properly discussed without requiring more labor than can be, at present, devoted to them.

Within the last few days the principal ray in the part near the nucleus, has assumed a more regular sweep in the direction opposed to that of the diffuse tail, which now reaches nearly to the centre of Corona Borealis, scarcely changing the course of its southern limit between κ and ι Bootis and ζ Coronæ Borealis from night to night.

The telescopic phenomena, though interesting, have not presented equally strongly defined features with those which char-

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acterized the great comet of 1858. We should perhaps except from this remark their structure for a day or two after their first emission from the nucleus. In this stage they were intersected by jets of luminous matter projected from the nucleus, and these limits were pretty clearly outlined.

On the 2d, portions of three were visible; the inner one showing a variety of details. In its outline and general aspect it was, like others which followed it, almost a fac-simile on an enlarged scale of some of those exhibited by the great comet of 1858. They rapidly faded, or were lost in the surrounding haze and their places were filled by new ones. Latterly, two, at most, could be seen at one time. It is quite important to remark that the successive envelopes resembled their predecessors not only in their general aspect but quite closely in the details of their structure; the luminous jets not issuing at random from all points alike of the nucleus, but continuing to follow a nearly similar course at each new discharge from its surface.

The most natural inference from this would seem to be that the nucleus, if it rotates at all upon an axis, does so very slowly. Of the pendulum-like vibrations of the luminous sectors ascribed by Bessel to the comet of Halley, nothing was seen; although the opportunity of witnessing them, had they existed, was very favorable, as the sectors were well displayed.

The nucleus was throughout brilliant, and, to appearance, solid, with a diameter of from 2″ to 3″.

The disposition of the nebulosity in the part of the tail contiguous to the head was nearly uniform throughout; the axial darkness being scarcely distinguishable, excepting on one occasion, July 3d.

The following positions have been derived from comparisons with neighboring stars.

1861.	Cambridge mean solar time.	α	δ
July 2,	$8^h\ 28^m\ 38^s$	$8^h\ 37^m\ 43^s.22$	$+62°\ 51'\ 17''.1$
3,	8 21 33	9 49 15 ·85	66 6 15 ·3
3,	10 39 52	9 56 6 ·58	66 16 05 ·1
4,	10 39 18	11 2 7 ·48	66 53 26 ·4
5,	12 9 26	11 57 9 ·67	66 3 22 ·0
6,	9 17 39	12 31 2 ·60	64 51 33 ·3
8,	10 20 5	13 21 36 ·05	61 46 13 ·7
9,	10 40 47	13 37 37 ·88	60 21 45 ·2
10,	9 39 12	13 49 26 ·80	59 9 34 ·1
12,	11 57 47	14 8 0 ·59	56 54 47 ·2
13,	9 47 55	14 13 59 ·24	56 5 25 ·7

The nucleus admitted of very precise observations; indeed it is a curious fact that it would be quite possible by means of proper comparisons with neighboring stars, to obtain the differences of terrestrial longitudes of the principal points at which

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it was observed, with a degree of precision only surpassed by the more refined methods known in astronomy.

The near approach of the present comet to the earth and the sharply defined point of its nucleus, illustrates the practicability of a method of determining the solar parallax with perhaps greater exactness than can be attained by any other means. Many comets have stellar points for their nuclei, visible in the larger telescopes, which admit of as accurate comparisons with neighboring stars as is practicable in measurements among the stars themselves. Many such have appeared within the last fifteen years. Suppose such a comet to be suitably placed so as to be observed simultaneously in different quarters of the globe, when at a distance from the earth of less than one-twentieth of the sun's distance. Under favorable circumstances it would not be hazarding too much to say, that in the course of its apparition the probable error of the solar parallax could be reduced within smaller limits than is possible by means of transits of Venus or of any other method. Such an opportunity might possibly afford an improved value of the mass of the earth.

The following elements of the comet have been computed at the Observatory by Messrs. Safford and Hall.

Elements of Comet II, 1861. By T. H. Safford.

T = 1861, June 11.1878.		Cambridge m. t.
log. q =		9·91299
$\pi - \Omega = \omega$		329° 40′·81
Ω	=	278 59 ·28
i	=	85 41 ·43
		Motion direct.

By A. Hall.

T = June 11.280.		Washington m. t.
π	=	248° 51′ 50″
Ω	=	278 59 23
i	=	85 41 27
log. q =		9·91352
		Motion direct.

From the above, Mr. Safford finds the following approximate ephemeris for $10^h\ 24^m$ m. t. Washington, Δ and r representing the distances from the earth and sun respectively.

1861.	α	δ	log. Δ	log. r
July 5,	178° 42′	+66° 8′	9·3404	9·9716
6,	188 21	64 45		
7,	195 24	63 13	9·4281	9·9800
8,	200 37	61 42		
9,	204 34	60 18	9·5051	9·9887
10,	207 39	59 2		
11,	210 5	57 54	9·5722	9·9975
12,	212 5	56 52		
13,	213 44	+55 57	9·6313	0·0066

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The following, computed by Mr. Hall for Washington mean midnight, will give an idea of the path of the comet previous to its becoming visible in the northern hemisphere.

W. m. t.	α	δ	log. Δ
June 12·5,	61° 39′·1	−26° 32′·3	9·7222
16·5,	63 16·3	23 18·4	9·6182
20·5,	66 4·9	17 11·6	9·4831
24·5,	71 56·9	− 3 45·4	9·3105
28·5,	85 17·9	+27 41·5	9·1420
July 2·5,	132 15·9	63 34·0	9·2027
6·5,	188 53·9	64 38·6	9·3884
10·5,	207 50·1	+58 56·5	9·5420
June 29·0,	89 30·4	+33 8·4	9·1330

The comet passed its ascending node June 28·086, Washington m. t., when the difference between the heliocentric longitude of the comet and of the earth was 2° 0′. The difference between the geocentric longitude of the comet and of the sun was 12° 29′. Log. of distance of the comet from the earth = 9·1529. Calling its brilliancy unity on July 2·5, we have

June 12·5,	Brilliancy = 0·11
16·5,	0·18
20·5,	0·33
24·5,	0·69
28·5,	1·41
July 2·5,	1·00
6·5,	0·50
10·5,	0·18

computed by the equation, brilliancy $= \frac{1}{r^2 \Delta^2}$.

It will be seen that the comet, at about the time of its perihelion, must have been well situated for observation at the Cape of Good Hope and other points in southern latitudes. The *calculated* brilliancy is indeed much less than on the 2d of July, being only about one-tenth—but it is well known that the formula cannot be relied upon for the variations of the light of comets, which is greatly influenced by their positions relatively to their perihelia.

It is probable that at least the head of the comet was much brighter at the middle of June than it was after the first of July, and we shall wait with much interest for accounts of it from southern observatories, especially from the Cape of Good Hope, which has often, in similar emergencies, proved itself the most important astronomical position occupied by any existing observatory.

From the above elements, the diameter of the nucleus may be variously estimated at from one hundred and fifty to three or

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four hundred miles. On July 2d the breadth of the head at the nucleus was 156,000 miles, the height of the inner envelope 11,500 miles, and the length of the tail about 15,000,000 miles.

The comet was seen between one and two o'clock on Sunday morning, June 30th, by Dr. Brünnow, at the Observatory of Ann Arbor. This is the earliest authentic account of its visibility which has come to my notice. The head could not have been seen on Friday evening, although observations to that effect have been reported. The extremity of the tail, however, must have been within view for some time previous, though too faint to attract notice.

The reports current of the identity of the comet with those of 1264 and 1556 are without any foundation.

4. *Continuation of Account of Comet II*, 1861; *by* G. P. Bond, *Director of the Observatory of Harvard College.*

With the exception of a single cloudy night, observations were made at this Observatory, on every evening from the 2d to the 21st July inclusive. A like succession of clear skies rarely occurs here. At the latter date, the comet had become much fainter, and was besides obscured by the moonlight. In the region near the nucleus, the outlines of the envelope could no longer be discerned —the distribution of the brighter portions of the nebulosity, however, could be seen to resemble that of the earlier jets. This peculiarity has been preserved up to the beginning of August.

The tail during the last days of July, as seen through an opera-glass or comet-seeker, has continued to show the narrow ray, now reduced to about 12° in length.

Near the head it forms the right hand side of the tail (as presented in the evening), which is the brightest and best defined. Further on, it seems to bend to the right hand with a decided curve; at least this was the impression to the eye, but it has become a very faint object. The hazy tail curving to the left, maintains its position and general form, but is greatly diminished in extent and brightness. Mr. Safford has computed the following elements from observations:

June 30th, Greenwich.
July 8th and 9th, } Observatory of
July 18th. } Harvard College.

Elements of Comet II, 1861.

T =	June 11.5018.	Washington m. t.	
log. q =		9.915048	
$\pi - \Omega$ =		330°20′48″·1	M. Eq. 1861.0
Ω =		278 58 40 ·3	
i =		85 37 7 ·0	

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The observations of June 30th and July 18th were exactly represented, and those of July 8th and 9th as follows, by the method of least squares. A comparison upon Aug. 3 is also added.

	c − o			c − o	
	$\Delta\alpha$	$\Delta\delta$		$A\alpha$	$A\delta$
July 8th,	+ 1″·7	0″·0	Aug. 3d,	− 8″·7	+ 23″·1
9th,	− 4 ·0	− 2 ·5			

The elements are somewhat closer approximations than those communicated in the previous notice, though not differing essentially from them.

The comet was observed extensively in Europe, on the evening of the 30th of June. The following passages are translated from a communication in No. 1316 of the *Astronomische Nachrichten*, from Prof. Secchi, Director of the Observatory of the Collegio Romano, dated Rome, July 1, 1861.

"Yesterday at 9^h 30^m, I noticed this immense train of light in the N.N.E. which I took for the smoke of the fireworks which they often have in the city on the festival of St. Peter and St. Paul, but I soon perceived that it was a comet. Its head was then so low that I could with difficulty take an approximate instrumental position, and at 9·39 m. t., I found its A. R. 6^h 37^m, and its dec. 45° 57′. After the head had set, the tail remained on the horizon, and was much more brilliant than the milky way.

About half an hour before midnight, the tail had reached its maximum development; it was very bright, and 6° broad at the pole star which was exactly in its centre. Thence it contracted considerably, the central part only remaining, which extended in a long band, tolerably bright, and about 2° broad, touching α Lyræ on one edge (the eastern), and passing the zenith, was lost in the milky way near the stars ζ and ε Aquilæ. Including the part below the horizon the length was 118°. This is truly surprising! After it had risen at 2 o'clock in the morning, I examined the details of the construction of the nucleus till about 3^h, and I found that the nucleus was elliptical, with its major axis situated transversely to the axis of the tail. The measure of this axis was 10″·05, and the minor axis was estimated as 2″ smaller, its light nearly equalling that of Saturn. It was well defined on all sides with a power of 200, only on the side towards the sun it was a little less sharp, while a great mass of jets of reddish light started from its edge in the form of a fan. The whole nucleus and the fan were surrounded with a halo, folding back in two branches to the right and left; the former longest and most brilliant; finally the whole was enveloped with a large, well defined, paraboloid segment. The distance from the apex of the paraboloid to the center of the nucleus was 8′ 12″, and that from the nucleus to the bend of the curved jets was 1′ 55″. The maximum breadth of the tail was about 6°." . . .

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Dr. Pape of Altona has examined carefully the question whether the earth was at any time within the tail of the comet, and concludes that at its nearest approach we were about 2,400,000 miles distant from its nearest edge, on the morning of June 29th at $2^h\ 24^m$.

This result (so far as it relates to the principal ray) is also indicated by Mr. Hall's calculations communicated in the earlier notice. Mr. Hall states the difference of the heliocentric longitude of the comet and of the earth, at the passage of the node, June 28·086 Washington mean time, to be 2° 00′ and the log. distance of the comet from the earth 9·1529.

Dr. Pape finds for the nodal passage June 28·10 Washington mean time, difference of longitudes =1° 59′. The results in other particulars are also substantially the same.

The following remarks have been translated from Dr. Pape's article in No. 1316 of the *Astronomische Nachrichten*:

"From the position of the comet with respect to the sun and the earth, we might conjecture the latter to have passed through the tail of the comet on the 28th or 29th of last June. As such a collision is of some interest, I have undertaken a slight calculation to obtain closer details. The passage of the comet through its ascending node took place, Berlin time, June 28·35 (28·10 Washington).

At this time, its true anomaly was 29° 37′·5, log. r=9·94449, its heliocentric longitude 278° 59′, its distance from the earth's orbit =0·1161. At the same time the heliocentric longitude of the earth was 277° 0′. Assuming that the axis of the tail coincided with the prolongation of the radius vector, the earth was at a distance of 0·0352 from this axis. (Mean distance of the earth from the sun =1.)

A consideration of the dimensions of the tail shows that, according to the data, no collision took place.

That point of the tail which lay in the earth's orbit was at a distance of =0·1162 from the nucleus; to determine the diameter of the tail at that point, I subjoin an observation of the 3d of July.

At 10 o'clock on the evening of that day, the angle which the prolongation of the radius vector of the comet formed with the direction from the earth to the comet, was =57° 40′; a point in the tail (which could be traced for about 60 degrees) at a distance =0·1162, had an apparent distance of 42° 24′ from the nucleus, and at the same time that the distance of this point from the earth =0·1457.

At a distance of about 42° from the nucleus, the breadth of the tail may have been 3°; hence it follows that its true diameter was 0·0076.

Now on June 28·35, the distance of the earth from the axis of the tail was 0·0352, so that the nearest particles of the tail passed

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by the earth at a distance of 0·031. This result however rests upon the supposition that the tail lay in the prolongation of the radius vector. In fact, it appears to have been curved in the plane of the orbit, so that the remotest particles of the tail passed through the plane of the ecliptic earlier than the nucleus. But in no case, did any collision take place. According to the above hypothesis, the least distance of the earth from the nearest of the tail particles was 0·025 at about 12 hours after the passage of the comet through the node."

Altona, July 9th, 1861.

The above calculations of Pape relate to the straight bright ray. There was, however, as will be seen by reference to the preceding part of this notice, a great mass of diffuse light which separated from the ray, and swept off towards *Corona Borealis* in the early part of July, reaching on the 4th to a distance of 40° from the nucleus, and having a breadth of 12° or 15°. This would have barely grazed the earth on the 30th of June. In a late number of the Bulletin of the Imperial Observatory at Paris, Mr. Hind suggests that a peculiar illumination of the sky noticed in England on that date was possibly "attributable to the commingling of the matter forming the tail of the comet with the earth's atmosphere." The observations on this day have a peculiar interest, from the fact that, at about 10^h mean time Greenwich, the earth passed the plane of the comet's orbit, and the outline of the tail presented to us was that of the section formed by a plane perpendicular to its orbit.

From its brilliancy and nearness to the earth, the opportunity of defining this section was perhaps the best which the history of astronomy has afforded. It is to be hoped that European astronomers, who it seems had the advantage of clear skies and a favorable position of the comet at the very hour of our crossing the orbit, have made good use of the occasion by recording carefully all peculiarities of the physical aspect.

Prof. Secchi has defined the position of the tail at $11^h\ 30^m$ m. t. at Rome, June 30, about 55^m after the earth's passage through the orbit plane. Comparing the position of an arc of a great circle drawn from the sun through the nucleus, which must have corresponded almost precisely with the projection of the plane of the orbit, we find that at the pole star the centre of the ray was about $1\frac{1}{3}°$ to the *east* of the circle.

At α Lyræ the eastern edge was at the same distance to the west of the circle, so that the entire breadth was on that side; the centre being distant

$$1\tfrac{1}{3}° + \tfrac{1}{2} \text{ (breadth of tail)}.$$

Again at ζ and ε Aquilæ the tail was about 4° to the east of the circle. There was therefore a decided *bend* in the tail

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which on account of the direction of the time of vision must have been *out of the plane of the orbit.* That its entire breadth should have been out of this plane, as it seems to have been near α Lyræ, is indeed a most remarkable feature and very important in its bearing upon the theory of the forces concerned in producing it. At later dates, as we have remarked in a previous notice, the tortuous path of the ray was obvious.

Cambridge, Mass., Aug. 8, 1861.

Cambridge, August 8th.

P. S.—A letter of the date June 17, received from Dr. Moesta of the National Observatory, Santiago, Chili, announces the appearance of "a brilliant comet" early in the month. Its position and motion agree with the ephemeris communicated in a former part of this notice. We extract the following observations:

	Mean time Santiago.	α	δ
1861, June 10,	$18^h\ 18^m\ 26^s{\cdot}1$	$4^h\ 3^m\ 52^s{\cdot}92$	$-27°\ 51'\ 8''{\cdot}8$
12,	17 46 16 ·4	4 6 5 ·17	−26 47 14 ·7

Cambridge, August 10th.

Mr. Safford's latest elements represent the Santiago observations as follows:—

	comp.—obs. Δα	Δδ
1861, June 10,	−36″·0	+22″·9
12,	−15 ·7	−16 ·6

There can not therefore be any considerable deviation of the orbit from a parabola.

The tail of the comet was seen 40° long by Liais at Rio Janeiro on the 14th of June.

5. *Additional Observations at the U. S. Naval Observatory, Washington.* Communicated by Lt. J. M. Gilliss, U. S. N.*

Upon attempting to compute an orbit for the comet, Prof. Hubbard found it impossible to represent the observed path by a parabola, and then obtained by the Gaussian method the following hyperbolic elements, based upon the places obtained by Mr. Ferguson on the 2d, 8th, and 17th of July. They give for the middle date the values $\Delta l = -0''{\cdot}33$, $\Delta b = -0''{\cdot}16$.

Time of perihelion passage,	1861, June 11.85294.	Wash. M. T.
Long. of perihelion,	249° 44′ 44″·58	M. equinox,
" " node,	278 59 49 ·72	1861·0
Inclination,	85 56 8 ·86	
Excentricity,	1·0265470	
Perihelion distance,	0·7453901	

* From Lt. Gilliss' paper, to appear in full in our next issue.

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The following is the list of observations, as far as reduced and compared with the above elements:

	Wash. M. T.	α	c.—o.	δ	c.—o.
	d	° ′ ″	″	° ′ ″	″
July	2·41250	130 48 6·8	+ 2·4	63 12 48·5	+ 1·3
	3·36480	147 56 52·0	+17·9	66 10 2·4	− 0·6
	·38102	148 14 48·1	− 9·5	66 11 49·9	− 4·7
	·63908	152 46 48·8	+24·8	66 34 17·6	− 2·5
	4·36786	164 40 26·8	+18·6	66 54 21·2	− 5·5
	6·37421	187 49 0·3	+ 2·5	64 51 1·7	− 5·8
	8·36769	200 12 23·3	− 0·5	61 50 2·0	− 0·8
	10·53104	207 46 0·2	− 1·4	58 58 55·8	− 9·4
	11·45260	209 59 3·0	+ 2·3	57 56 58·2	−10·2
	12·42192	211 54 9·1	+ 8·9	56 58 12·1	− 7·8
	14·43062	214 56 37·2	+ 7·5	55 14 25·5	− 6·1
	16·37969	217 6 9·6	−13·4	53 52 5·4	+ 5·2
	17·35071	217 58 33·0	− 4·8	53 16 37·0	+ 1·5
	·42154	218 1 58·8	+ 4·2	53 14 13·7	− 3·8
	20·40982	220 9 34·0	+16·7	51 42 28·5	− 3·8
	23·37224	221 44 40·7	+19·5	50 30 17·2	− 9·1
	24·35193	222 11 27·8	+28·1	50 9 26·8	− 9·8
	25·36437	222 37 26·0	+32·5	49 49 15·3	−13·2
	27·37080	223 24 38·3	+36·0	49 12 25·8	− 8·9

From these residuals it is evident that the orbit requires yet some correction, not sufficient, however, it is believed, to change its decided hyperbolic nature.

6. *Elements of the Comet, in a letter to the Editors*, by Mr. M. C. Stevens.

I took the position of the late great comet on the 4th, 8th and 12th ult., at our Observatory with the following results:

Mean time of Observation.	Geocentric Long. of	Geocentric Lat. of
	° ′ ″	° ′ ″
July 4.39260	129 31 32	53 25 51
" 8.40480	155 48 12	60 55 24
" 12.37426	171 31 42	62 7 7

From these I have computed the following elements of its orbit:—

Long. of ascending node,	° ′ ″ 278 57 52
Inclination of orbit,	85 38 7·5
Long. of perihelion,	248 30 31
Perihelion distance,	Log. 9·91248
Perihelion passage, 1861, June 11.12177. Motion direct.	Washington M. T.

Haverford Observatory, West Haverford, Pa., 8th mo. 15th, 1861.

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SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY.

TECHNICAL CHEMISTRY.—

5. *On the Coloring Matters Derived from Coal-Tar;* by Mr. H. W. PERKIN, F.C.S. (A lecture delivered before the [London] Chemical Society on Thursday, May 16, 1861); from the [London] Journal of Gas Lighting, etc. p. 447, June 18, 1861.—The subject which I have the honor of bringing before you this evening is one which is remarkable for the very rapid progress it is making. Previous to the year 1856, the coloring matters derived from coal-tar products were practically unknown; but, owing to recent discoveries, they are now enumerated among the most important coloring matters employed. It is not my intention to enter into a discussion respecting the numerous patents that have been taken out for the prodution and application of coal-tar colors, nor yet to enter into the practical details of their manufacture; but to notice more particularly their various chemical characters, and also to speak of the methods employed for their application to the arts. I shall endeavor to bring before you all the principal colored products obtainable from the derivatives of coal-tar—both those which are practically employed by the dyer and printer, as well as those which still remain as chemical curiosities only. I may mention that the latter class of compounds is more extensive than the former, and also that many of the coloring matters in it are likely to remain so, for reasons to be mentioned presently.

The coal-tar products which have, up to the present, yielded coloring matters, are numerous. The following is a list of the most important, which are obtained either directly or indirectly from coal-tar:—namely, aniline and its homologues, carbolic acid, chinoline or quinoline, naphthaline, and pyrole bases.

I will commence by speaking of the first and most important of these products, and its derivatives—namely, Aniline.

Aniline was discovered in 1826 by Unverdorben. The original method for its preparation was by digesting indigo with hydrate of potassa, and subjecting the resulting product to distillation. Aniline was also obtained from the basic oils of coal-tar; but the process which is now employed for its preparation is a remarkable instance of the manner in which abstract scientific research becomes, in the course of time, of the most important practical service. It was Faraday who first discovered benzole; he found it in oil-gas. After this, it was obtained by distilling benzoic acid with baryta, which result determined its formula, and was the cause of it being called *benzole*. After this, Mansfield found it to exist in large quantities in common coal-tar naphtha, which is the source from which it is now obtained in very large quantities. Benzole, when studied in the laboratory, was found to yield, under the influence of nitric acid, nitrobenzole. Zinin afterwards discovered the remarkable reaction which sulphid of ammonium exerts upon nitrobenzole, converting it into aniline. And, lastly, Béchamp found that nitrobenzole was converted into aniline when submitted to the action of ferrous acetate. It is Béchamp's process which is now employed for the preparation of aniline by the ton. Had

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it not been for the investigations cited above, the beautiful aniline colors now so extensively employed, would still remain unknown. When I discovered aniline-purple, nitrobenzole and aniline were only to be met with in the laboratory; in fact, half a pound of aniline was then esteemed quite a treasure, and it was not until a great deal of time and money had been expended that I succeeded in obtaining this substance in large quantities, and at a price sufficiently low for commercial purposes.

The coloring matters obtainable from aniline are numerous. They are the following:—Aniline purple, violine, roseine, fuchsine, alpha aniline purple, bleu de Paris, nitroso-phenyline, dinitraniline, and nitro-phenyline diamine.

Aniline Purple, generally known as Tyrian Purple, Mauve, Phenamine, Indisine, &c.—It has been known for many years that the hypochlorites react on aniline and its salts, producing a purple-colored solution; in fact, hypochlorites are the distinguishing test for aniline; but nothing definite was known of this purple-colored solution, it being simply stated that aniline produced, with hypochlorites, a purple-colored liquid, but that this color was very fugitive. As many very absurd statements have been made respecting the discovery of aniline purple, I will just briefly mention how it was that I first became acquainted with it.

In the early part of 1856, I commenced an investigation on the artificial formation of quinine. To obtain this base, I proposed to act on toluidine with iodid of allyle, so as to form allyle-toluidine, which has the formula—

$$\left.\begin{matrix} C_7H_7 \\ C_3H_5 \\ H \end{matrix}\right\} N = C_{10}H_{13}N,$$

thinking it not improbable that, by oxydizing this, I might obtain the desired result; thus—

$$\underbrace{2(C_{10}H_{13}N)}_{\text{Allyle-toluidine.}} + O_3 = \underbrace{C_{20}H_{24}N_2O_2}_{\text{Quinine.}} + H_2O.$$

For this purpose, I mixed the neutral sulphate of allyle-toluidine with bichromate of potassa; but, instead of quinine, I obtained a dirty reddish-brown precipitate. Nevertheless, being anxious to know more about this curious reaction, I proceeded to examine a more simple base under the same circumstances. For this purpose, I selected aniline, and treated its sulphate with bichromate of potassa. This mixture produced nothing but a very unpromising black precipitate; but, on investigating this precipitate, I found it to contain the substance which is now, I may say, a commercial necessity—namely, aniline purple.

The method adopted for the preparation of analine purple is as follows:—Solutions of equivalent proportions of sulphate of aniline and bichromate of potassa are mixed, and allowed to stand till the reaction is complete. The resulting black precipitate is then thrown on a filter, and washed with water until free from sulphate of potassa. It is then dried. This dry product is afterwards digested several times with coal-tar naphtha, until all resinous matter is separated, and the naphtha ceases to be colored brown. After this, it is repeatedly boiled with alcohol to extract the coloring matter. This alcoholic solution, when distilled, leaves the col-

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oring matter in the bottom of the retort as a beautiful bronze-colored substance.

The aniline purple prepared according to the process just described, although suitable for practical purposes, is not chemically pure. If required pure, it is best to boil it in a large quantity of water, then filter the resulting colored solution, and precipitate the coloring matter from it by means of an alkali. The precipitate thus obtained should be collected on a filter washed with water until free from alkali, and dried. When dry, it is to be dissolved in absolute alcohol, the resulting solution filtered, and then evaporated to dryness over the water-bath. Thus obtained, aniline purple appears as a brittle substance, having a beautiful bronze-colored surface; but, if some of its alcoholic solution be evaporated on a glass plate, and viewed by transmitted light, it appears a beautiful bluish violet color. If considerable quantities of an alcoholic solution of the coloring matter, containing a little water be evaporated to dryness, the surface of the coloring matter next to the evaporating dish, when detached, often possesses a golden-green appearance. Aniline purple is difficultly soluble in cold water, although it imparts a deep purple color to that liquid. It is more soluble in hot water, but its hot aqueous solution, when left to cool, assumes the form of a purple jelly. It is very soluble in alcohols, though nearly insoluble in ether and hydrocarbons. Aniline dissolves it readily. In properties it seems to be slightly basic, as it is more soluble in acidulated than in pure water. Alkalies and saline substances precipitate it from its aqueous solution as a dark purplish-black powder. Bichlorid of mercury precipitates it in a very finely-divided state. A little of this precipitate, which appears to be a double compound of chlorid of mercury and coloring matter, when suspended in water and viewed by transmitted light, appears of a blue or violet color. If a small quantity of hydrate of potassium or sodium be added to an alcoholic solution of the coloring matter, it causes it to assume a violet tint, but without effecting any change in the coloring matter itself. Ebullition with alcoholic potash does not decompose it. Aniline purple dissolves in concentrated sulphuric acid, forming a dirty-green solution. This, when slightly diluted, assumes a beautiful blue color. Excess of water restores it to its original purple color. I have had a specimen of this coloring matter heated for an hour to 100° centigrade, with Nordhausen sulphuric acid without suffering decomposition, being restored to its original color by means of water, and possessing precisely the same properties as it had before being subjected to this powerful agent. Hydrochloric acid acts upon it in the same manner as sulphuric acid. It is decomposed by chlorine, and also by fuming nitric acid. Bichlorid of tin is without action upon it. Powerful reducing agents have a peculiar action upon this coloring matter, somewhat analagous to the action of reducing agents on indigo. An alcoholic solution of sulphid of ammonium, when mixed with an alcoholic solution of the coloring matter, causes it to assume a pale, slightly brownish color. This solution, when brought in contact with the atmosphere, instantly assumes its beauty and intensity of color. An alcoholic solution of the coloring matter, when mixed with a little protoxyd of iron, changes to a pale-brown color. This solution also becomes purple when exposed to the action of the atmosphere. Sulphurous acid does not affect the color of this substance.

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The coloring matter forms a remarkable compound with tannin. When an aqueous solution of the coloring matter is mixed with a solution of the tannin, precipitation takes place. The precipitate thus formed, after having been well washed, no longer possesses the properties of the pure coloring matter. It is insoluble in water. Like the pure coloring matter, it dissolves in concentrated sulphuric acid, forming a dirty-green liquid; but, on adding an excess of water to this solution, the new compound is precipitated unchanged. This compound is rather duller in color than the pure coloring matter itself. Aniline purple, when agitated with a little moist binoxyd of lead, is transformed into roseine. This coloring matter is remarkable for its intensity—a few grains of it coloring a considerable quantity of spirits of wine.

Violine.—This coloring matter, which is a product of the oxydation of aniline, was first obtained by Dr. David Price. He prepared it by heating an aqueous liquid containing two equivalents of sulphuric acid, and one equivalent of aniline, to the boiling-point, and then adding one equivalent of binoxyd of lead, boiling the mixture for some time, and filtering it whilst hot. The filtrate, which is of a dark purple hue, is boiled with potash, both to separate the excess of aniline, and also to precipitate the coloring matter. When all the free aniline is volatilized, the residue is thrown on a filter, and slightly washed with water, and then dissolved in a dilute solution of tartaric acid. This solution after filtration is evaporated to a small bulk, refiltered, and then precipitated by means of an alkali. Thus obtained, violine presents itself as a blackish-purple powder, which, when dissolved in alcohol, and evaporated to dryness, appears as a brittle, bronze-colored substance, similar to aniline purple, but possessing a more coppery-colored reflection. It is more insoluble in water than the preceding coloring matter; it is very soluble in alcohol, but insoluble in ether and hydrocarbons. These solutions possess a color somewhat similar to that of the field violet. Concentrated sulphuric acid dissolves it, forming a green solution, but excess of water restores it to its original color. Like aniline purple, reducing agents deprive it of its color, but which is restored by the action of the atmosphere. Tannin produces an insoluble compound with it; when agitated with a small quantity of binoxyd of lead, it is converted into aniline purple; excess of this reagent changes it into roseine.

Roseine.—This substance nearly always accompanies aniline purple, though in very small quantities. It was first noticed publicly by C. Greville Williams, and afterward by Dr. David Price. Williams used manganates for its preparation, but Dr. David Price prepared it by means of binoxyd of lead. His process is as follows:—To a boiling solution of one equivalent of sulphate of aniline, two equivalents of binoxyd of lead are added, and the mixture boiled for a short time. The rose-colored solution is then filtered, and the filtrate evaporated to a small bulk, which causes a certain amount of resinous matter to be separated. This evaporated solution is then filtered, and the coloring matter precipitated by means of an alkali; it is then collected on a filter, slightly washed, and then dried. The coloring matter thus prepared readily dissolves in alcohol, forming a fine crimson-colored liquid, which, when evaporated to dryness, leaves the coloring matter as a dark brittle substance, having a slightly metallic reflection. It is much more soluble in water than

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either aniline purple or violine; but, like them, it is insoluble in hydrocarbons, and is more soluble in acids than in neutral liquids. Concentrated sulphuric acid dissolves it, forming a green solution; excess of water restores it to its original color. It forms a compound with tannin, and is also deodorized, or nearly so, by powerful reducing agents.

The three coloring matters just mentioned, namely, aniline purple, violine, and roseine, are evidently closely allied, for they have nearly the same properties. They are all formed under similar circumstances, namely, by the action of oxydizing agents in the presence of water; they are all slightly soluble in water, though as the shade of color becomes redder, so their solubility increases; alkalies precipitate them from their aqueous solutions; concentrated sulphuric acid dissolves them, forming green solutions, which excess of water restores to the original color of the coloring matters; powerful reducing agents deprive them of their color, or nearly so; but it is again restored by the influence of oxygen; and, lastly, tannin forms insoluble compounds with them all.

Fuchsine or Magenta.—This beautiful product, which is often improperly called roseine, is a member of an entirely different series of compounds from the foregoing, being formed under very different circumstances, and possessing very different properties. This coloring matter was first observed by Natanson, in 1856, when studying the action of chlorid of ethylene on aniline, and afterwards, shortly before it was practically introduced into the arts, by Dr. Hofmann, when preparing cyantriphenyle-diamine by the action of bichlorid of carbon on aniline. It was Mr. Verguin who first brought it forward as a dyeing agent, and who, I believe, taught manufacturers how to prepare it on the large scale. Fuchsine is invariably formed at a temperature ranging from 170° to 190° centigrade. It is produced from aniline by the action of reducible chlorinized, brominized, iodized, or fluorized substances, as well as by weak oxydizing agents. The substances used for its preparation on the large scale are perchlorids of tin and of mercury, and the nitrates of mercury. It has also been prepared with bichlorid of carbon.

Preparation of Fuchsine by the Action of Bichlorid of Tin on Aniline.—Aniline combines with bichlorid of tin, evidently producing a double compound. This product is a white substance, and may be prepared by adding to aniline, bichlorid of tin in the anhydrous state, or dissolved in water. Anhydrous bichlorid of tin combines with aniline with great energy to form this compound. To prepare fuchsine from this double compound, it is necessary that it should be free from water, or nearly so; therefore, anhydrous chlorid of tin is generally employed for its preparation. The process adopted is as follows:—Anhydrous bichlorid of tin is slowly added to an excess of aniline, the mixture being constantly stirred, and the pasty mass thus formed gradually heated. As the temperature increases, it becomes quite liquid and also brown in color. As soon as the temperature nearly approaches the boiling point of the mixture, it rapidly changes to a black-looking liquid which, when viewed in thin layers, presents a rich crimson color. This is kept at its boiling point some time, and then well boiled with a large quantity of water. By this means, the principal part of the coloring matter is extracted, together with considerable quantities of hydrochlorid of aniline. The residue is a solid of brown color, and contains considerable quantities of

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tin in the form of a proto-compound. The aqueous solution of the coloring matter and hydrochlorate of aniline is then boiled, so as to volatilize any free aniline it may contain, and then saturated with chlorid of sodium. The chlorid of sodium causes the coloring matter to separate as a semi-solid pitchy substance, of a golden-green aspect, while the hydrochlorate of aniline remains in solution. The coloring matter thus obtained may be further purified by digestion with benzole, which dissolves out a certain amount of resinous matter.

Preparation of Fuchsine by the Action of Nitrate of Mercury on Aniline.—When protonitrate of mercury is left in contact with aniline for some time it forms a white pasty mass; but when carefully heated to 170° or 180° centigrade, it reacts upon it, forming a brown liquid, which gradually changes till of a dark crimson color. At the same time, the whole of the metal of the mercury-salt collects at the bottom of the vessel the experiment is conducted in. This product, when separated from the metallic mercury and allowed to cool, becomes semi-solid, being filled with crystals of nitrate of aniline. To purify this product, it is best to dissolve out the nitrate of aniline it contains in a small quantity of cold water, and then to boil the remaining product several times with fresh quantities of water until the principal of the coloring matter is extracted, and filter the resulting aqueous solutions while hot. On cooling, the solutions will deposit the coloring matter as a golden-green tarry substance, from which benzole separates a small quantity of a brown impurity, leaving the coloring matter as a brittle solid.

I have briefly described the above processes, because they may to some extent be regarded as types of most of the methods employed for the production of this coloring matter—the first representing its formation by the action of reducible chlorids upon aniline, and the latter by the influence of weak oxydizing agents.

Fuchsine is undoubtedly an organic base, and a more powerful one than is generally supposed. The product obtained from aniline by means of bichlorid of tin is hydrochlorate of fuchsine, and that obtained by the oxydizing action of nitrate of mercury is the nitrate of fuchsine. My reason for stating this is, that, on examining the coloring matter obtained by chlorid of tin, I found it to contain large quantities of combined hydrochloric acid, and, when nitrate of mercury was used, considerable quantities of combined nitric acid; therefore, I concluded that the former is the hydrochlorate, and the latter the nitrate.

Fuchsine is separated from its salts by precipitation with a small quantity of ammonia. When freshly precipitated, fuchsine is a red bulky paste, which, when dry, contracts, forming a purplish red powder. It is difficultly soluble in water, though tolerably soluble in alcohol; it is not soluble in ether or hydrocarbons; a small quantity of hydrochloric acid causes it to dissolve freely in hot water; but an excess of either hydrochloric acid or sulphuric acid dissolves it, forming a brownish yellow liquid from which ammonia separates it unchanged. By this reaction it may be distinguished from roseine, which dissolves in strong sulphuric acid, producing a green liquid. Caustic alkalies, or ammonia in excess, partially precipitate fuchsine from its salts; but, at the same time, dissolve a considerable quantity of it, forming nearly colorless liquids.

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Acetic acid added to these alkaline solutions restores the color of the fuchsine; and, if the liquids are concentrated, the base precipitates as a red, flocculent substance. An alcoholic solution of fuchsine, when evaporated to dryness, leaves the coloring matter as a brittle mass, having a remarkably beautiful golden-green metallic reflection. By transmitted light it has a red color. Mr. Béchamp has analyzed carefully-prepared specimens of fuchsine, and found it to have the formula $C_{12}H_{12}N_2O$. This hydrochlorate he found to contain an amount of hydrochloric acid, corresponding with the formula $C_{12}H_{12}N_2O$, H Cl. He also examined the hydrochloroplatinate, which is a purple precipitate; it has the formula $C_{12}H_{12}N_2O$ H Pt Cl_3. The existence of oxygen in this base is remarkable, because, in many instances, it is produced from agents which do not contain a trace of oxygen—as, for example, bichlorid of tin and aniline. The only way I can account for the presence of oxygen in the product analyzed is, that it was a hydrate; thus:—

$$\underbrace{C_{12}H_{12}N_2O}_{\text{Béchamp's fuchsine.}} = \underbrace{C_{12}H_{10}N_2}_{\text{Anhydrous fuchsine.}} + \underbrace{H_2O}_{\text{Water.}}$$

This is, perhaps, to some extent, confirmed by an experiment I made with iodaniline. I find that iodaniline, when heated, yields fuchsine. This change can only be expressed thus:—

$$\underbrace{2(C_6[H_6I]N)}_{\text{Iodaniline.}} = \underbrace{C_{12}H_{10}N_2}_{\text{Anhydrous fuchsine.}} + 2HI$$

But, supposing the fuchsine examined by Mr. Béchamp to have been a hydrate, it is remarkable that its hydrochlorate, and, more particularly, its hydrochlorplatinate, should also be hydrates. But, as our knowledge of this body is as yet but scanty, we must wait for the accumulation of facts before we can form any fixed opinion respecting its constitution. The compounds investigated by Mr. Béchamp appear to be uncrystallizable. Some time back, I had upwards of 100 gallons of a hot, aqueous solution of this coloring matter, which had been prepared by means of nitrate of mercury. This solution, on standing until cold, deposited a considerable quantity of coloring matter in the form of small octahedra, having a most beautiful green metallic reflection. Reducing agents decolorize fuchsine, but the oxygen of the atmosphere restores it to its original color. If an alcoholic solution of fuchsine be left in contact with sulphid of ammonium until decolorized, or nearly so, and then exposed to the atmosphere, its color is immediately restored; but, if left to stand for several days, and then submitted to the atmosphere, several hours elapse before it assumes its original color. Like aniline purple, fuchsine is a very intense coloring matter. Tannin precipitates both fuchsine and its salts, forming difficultly soluble substances. Bichlorid of mercury also precipitates this base and its salts, forming double compounds. When preparing fuchsine by means of bichlorid of tin, or more particularly when using nitrate of mercury, there are two other coloring matters produced, one possessing an orange color, and the other a purple hue. It is on account of the presence of the former that some samples of commercial fuchsine possess a scarlet character of color. Of this

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orange-coloring matter, scarcely anything is known. It is not precipitated from these salts by means of alkalies. Of the purple-coloring matter, little is also known. It is formed at the same time as fuchsine, but in very small quantities, and from which it is difficult to separate perfectly. Its properties are similar to those of fuchsine. It dissolves in concentrated sulphuric acid, forming a reddish-brown solution, from which part of the coloring matter is separated by dilution with water. Hydrochloric acid dissolves it, forming a dirty, yellowish-red liquid.—(*To be continued.*)

2. *Action of Sulphate of Copper when employed as a preservative of wood.*—Kœnig has investigated the chemical reactions which occur when wood is impregnated with a preservative solution of blue vitriol. He finds as a general rule, that a certain quantity of basic sulphate of copper remains combined in the pores of the wood in such a manner that it cannot be washed out with water. The copper salt may be seen by its green color in the spaces between the yearly rings in the less compact portions of the wood, that is to say in those portions which contain the sap. Those varieties of wood which contain the most resin retain the largest amount of the copper salt,—oak, for example, retaining but little of it. The ligneous fibre itself appears to have little or nothing to do with the fixation of the copper salt, and indeed none whatever is retained in chemical combination, so that it cannot be washed out with water, by pure cellulose. When wood from which all resin has been extracted by boiling alcohol, is impregnated with sulphate of copper, it does not become colored like the original resinous wood, and the copper salt contained in it may readily be washed out with water. In like manner, from impregnated resinous wood all the copper salt may be removed, with the resin, by means of alcohol.

The constituents of the blue vitriol are consequently fixed in the wood by means of the resin which this contains.

Further it is found that the impregnated wood contains less nitrogen than that which is unimpregnated and that it is even possible to remove all the nitrogenous components of the wood by long continued treatment with the solution of sulphate of copper. The nitrogenous matters being soluble in an excess of this solution just as the precipitate which forms when aqueous solutions of albumen and sulphate of copper are mixed is soluble in excess of the latter. Since the nitrogenous matters are well known to be promoters of putrefaction, their removal readily accounts for the increased durability of the impregnated wood.

The author hopes to explain in a similar manner the action of other salts, like chlorid of zinc, &c., which are used for preserving timber, and is now engaged in investigating the question.

The utility of blue vitriol as a preservative may also depend in a measure upon the resiuous copper salt which is formed, by which the pores of the wood are more or less filled up and the ligneous fibre covered so that contact with the air is prevented and the attacks of insects hindered. It is suggested that those cases in which the anticipated benefits have not been realized in practice by impregnating wood with a solution of blue vitriol, may probably be referred to the use of an insufficient amount of this agent—i. e., where the wood was not immersed in the solution for a sufficient length of time. The action should be one of lixiviation, not

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merely of absorption.—*Programm der Realschule zu Leipzig*, 1861; Bœttger's *polyt. Notizblatt*, xvi, 177, (1861, No. 12).

3. *Ozone as a means of restoring old and faded engravings, etc.*—According to v. Gorup-Besanez, ozone when properly applied is a most effective and convenient agent for restoring books or prints which have become brown by age, or been soiled or smeared with coloring matter; only a short time being required to render them perfectly white, as if just from the press, and this without injuring in the least the blackness of the printer's ink or the lines of crayon drawings.

As examples of his results the author mentions a book of the sixteenth century upon a page of which several sentences had been painted over, by the monks of that epoch, with a black, shining coloring matter in order to render them illegible, and of which no trace of a line could be detected. After 36 hours treatment with ozone the coloring matter was entirely destroyed, and the most careful scrutiny of the page would have failed to discover that any of the lines had once been painted over. In like manner a wood cut of Durer which had been besmeared with a dark yellow color was completely restored.

Writing ink may be readily discharged by ozone, especially if the paper be subsequently treated with very dilute chlorhydric acid to remove the oxyd of iron.

Printer's ink is not attacked by ozone to any appreciable extent unless the action be long continued. Vegetable coloring matters are completely removed by it, but metallic coloring matters, grease spots and stains produced by fungi cannot thus be destroyed.

As applied in the small way, the method consists in placing a bit of phosphorus about 3 inches in length and ½ an inch in diameter, the surface of which has been scraped bright, in a wide necked glass carboy, or other large hollow vessel, pouring in as much water, at about 30° (C.), as will half cover the phosphorus, closing the vessel with a cork, and allowing the whole to stand until the jar is charged as strongly as possible with ozone, which ordinarily occurs after 12 or 18 hours. Then without removing the phosphorus or water, the paper to be bleached, which has been moistened with water, rolled up, and fastened to a platinum wire in a suitable manner, is hung in the middle of the vessel. The cork is now restored and the apparatus left to itself. The roll of paper is soon surrounded with the fumes arising from the phosphorus and the stains gradually disappear. The rapidity of the operation of course depends upon the nature of the substance to be discharged—three days having been the longest time required in any of the experiments. Prints which had merely become brown by age and those stained with coffee usually become perfectly white and clean in the course of 48 hours. The action of the ozone however must not be continued too long lest some of the finer lines of the engraving should be injured. After all the spots have disappeared, the paper is strongly acid and if allowed to dry when in this condition would become exceedingly brittle and also dark colored. It is consequently necessary to remove the acid completely. In order to accomplish this the paper is placed in water which is frequently renewed and allowed to lie there until a bit of blue litmus paper pressed against it is no longer reddened. The paper is then passed through water to

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which a few drops of a solution of soda have been added and is spread upon a glass plate, this is slightly inclined and a fine stream of water is allowed to flow over the paper during 24 hours. After the paper, on exposure to the air, has become dry enough to remove from the glass without danger of tearing, it is taken off and pressed dry between folds of filter paper.

The author remarks that in case the process were attempted on a larger scale it would probably be well to have glass troughs or boxes blown of the desired form, since it is not easy to prepare suitable vessels by any process of fastening together pieces of glass, the cement being attacked by ozone.

Attempts to apply ozone in restoring oil paintings gave only negative results, the action having been irregular.—*Annalen der Chemie und Pharmacie*, cxviii, 232.

4. *New Anæsthetic.*—During the past few months considerable interest has been excited among members of the medical profession by an attempt to introduce into practice a volatile liquid possessing anæsthetic properties which is obtained as an incidental product in the manufacture of coal oil. Of the chemical history of this substance—called keroselene by its manufacturers, but little is as yet known. Prof. Bacon, of the Harvard Medical School, informs us "that a sample in his possession is of sp. gr. 0·640, at 72° F. When heated in a flask containing scraps of platinum foil it began to boil at about 85° F. As the more volatile parts distilled off, the temperature continued to rise, and at 170° about three-quarters of the liquid had evaporated. It continued to boil feebly, but the whole was not converted into vapor until the thermometer had risen considerably above 300°; and when the flask was allowed to cool, much of the vapor condensed before the temperature had fallen to 300°. It is evident that several, perhaps many, hydrocarbons are present, having a wide range of boiling points. Probably the most volatile of them would be gaseous at ordinary temperatures, if isolated. It is remarkable that the keroselene should be so readily and completely volatile at atmospheric temperatures. I found that keroselene and Squibb's ether, exposed in watch glasses, lost equal weights in 2½ and 3½ minutes respectively; and the former evaporated completely in about two-thirds of the time required for the ether. The specimen which I examined contained a little *sulphur*. Some sulphur compound was therefore present as an impurity, which would be decidedly objectionable for anæsthetic purposes."

The vapor of this substance possesses very decided anæsthetic properties. This was first accidentally noticed by its effects upon a laborer engaged in cleaning a cistern at a coal-oil manufactory, and afterwards proved by the workmen by experiments upon flies and mice. Whether it can be employed without danger as a substitute for ether or chloroform is as yet undecided. Dr. H. J. Bigelow (Boston Medical and Surgical Journal (July 11, 1861) lxiv, 494,) reports several cases in which its exhibition was attended with unfavorable symptoms; and at the present time the general feeling of medical men in Boston with regard to its value is evidently much less favorable than when it was first brought forward. It may be remarked that the "keroselene" in question is

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exceedingly well purified as far as relates to its odor, being almost entirely free from the objectionable smell which characterizes most of the light coal oils. F. H. S.

Boston, Aug. 20.

ANALYTICAL CHEMISTRY.—

5. *Reinsch's test for Arsenic not applicable to solutions containing Arsenic acid.*—WERTHER finds that the practice of applying Reinsch's test immediately to the liquid obtained by the action of chlorate of potash and chlorhydric acid upon the substance suspected to contain arsenic must be discarded and that, as a general rule, the test is inapplicable to liquids which contain arsenic acid.

It had heretofore been supposed, and the belief is countenanced by so high an authority as Fresenius (*Anleitung zur qualitativen chem. Analyse*, 10^te *Aufl.*, p. 148, §132, No. 7), that arsenic acid would readily be reduced by the copper employed in the test and that the products of this reduction would not interfere with the deposition of the characteristic arsenical coating upon the copper. But Werther now shows that solutions either of free arsenic acids, or of its salts in chlorhydric or sulphuric acid deposit no coating upon bright metallic copper unless a considerable quantity of arsenic acid be present. Similar negative results were obtained from solutions which were allowed to stand upon the copper in the cold for months and from others which were boiled at longer or shorter intervals.

It is consequently with arsenious acid alone that the characteristic reaction of arsenic can be exhibited when dilute solutions of the latter are boiled with copper and chlorhydric acid.

In the experiments of the author no unequivocal, lustrous, arsenical coating upon the copper could be obtained, on boiling for a few minutes, from acid solutions of arseniate of magnesia and ammonia unless these contained at least 0·4 à 0·5 grm. of arsenic in 50 cc.; although dark colored coatings of uncertain composition, from which no arsenic could be obtained by volatilization in a current of hydrogen or of carbonic acid, were obtained from more dilute solutions.

In judicial investigations, therefore, Reinsch's test should never be employed upon the liquid resulting from the oxydation of organic substances, until the arsenic acid therein contained has been reduced by a current of sulphurous acid.

Having observed that the dubious black coating sometimes obtained from dilute solutions of arsenic acid, as just described, frequently disappeared again as he sought to increase it by longer continued action, the author was led to the observation that not only the coating in question but pure metallic arsenic is gradually dissolved by chlorid of copper when this is gently heated. After having acted during a few hours the solution contains considerable quantities of arsenic acid but scarcely a trace of arsenious acid.

On the other hand common chlorhydric acid diluted with an equal volume of water being boiled upon bright metallic arsenic dissolved none of it, nor was any dissolved after digesting for two days at 50° à 60° (C.) in a closed vessel.—*Journal für praktische Chemie*, lxxxii, 286.

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II. GEOLOGY.

1. *Reply to Mr. Marcou's strictures on Mr. F. B. Meek in his Notes on the Cretaceous and Carboniferous Rocks of Texas*, (in a letter to the Editors.)—GENTLEMEN:—I had intended never to answer any of Mr. Marcou's papers on the disputed points in the geology of the far-west, excepting at such times as I could do so in connection with the announcement of newly discovered facts. To prolong a discussion of this kind by merely reiterating opinions already expressed, after all the facts in possession of the parties have been published, can neither advance the interests of science, nor prove very interesting to scientific readers. In a paper recently published by Mr. Marcou, however, he makes some statements of a personal nature, which my friends think, if allowed to pass unnoticed, may place me in a false position.

The paper to which I allude is entitled, "Notes on the Cretaceous and Carboniferous rocks of Texas, by Jules Marcou,"—and was published in the VIIIth volume of the Proceedings of the Boston Society of Natural History. It is intended as a critical review of a paper by Dr. B. F. Shumard, containing a section of the Texas formations; and the personal remarks to which my attention has been called, are made incidentally in connection with this review.

The first of these remarks worthy of notice, (and it is of no very great importance,) occurs on page 94, where he mentions an error on one of the plates of the VIIth volume of the Pacific Railroad Reports, in copying a figure from a paper of his in the Bulletin of the Geological Society of France, citing it as an instance of the careless work of "Messrs. Hall, Blake and Meek."

Now the fact is, the figures referred to by Mr. Marcou, were not copied by me, as I have already explained to him by letter. The other figures on the same plate were drawn by me from specimens left by Mr. Blake at Albany, N. Y., where I was then living. Each of my drawings was on a separate piece of paper when they went out of my hands. The other figures from Mr. Marcou's paper, were copied and arranged on the same plate with them by some person at Washington City; and it was not until I saw a proof of the plate sent on to Albany, that I was aware these figures had been copied from Mr. Marcou's paper.

After the publication of the volume containing this plate, I received a letter from Mr. Marcou, who was then in Switzerland, complaining that I had received credit for drawing a plate in it which contained a few figures that had been copied from a paper of his. To this I replied, informing Mr. Marcou that the figures referred to by him, were not copied by me, and that I was not aware my name would be mentioned in connection with *any* of the drawings in this report, until I saw it in print.

As I received an answer from Mr. Marcou (dated Zurich, July 1st, 1858, which is now in my possession) acknowledging the reception of my letter, and expressing satisfaction with the explanation in regard to the plate, I am a little surprised that he should now connect my name with it; though it is possible the nature of our correspondence on the subject may have escaped his memory.

On page 96 of his Boston paper already alluded to, Mr. Marcou, in speaking of the so-called *Gryphæa Tucumcarii*, says, "On looking more

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closely at the plates of the *Mexican Boundary* Report, I found on the last plate, No. XXI, fig. 3a, 3b, 3c, a specimen of *Gryphæa Tucumcarii* under the false name of *Gryphæa Pitcheri*. Mr. Conrad in his description of *Gryphæa Pitcheri*, p. 155, makes no reference whatever to that plate, nor to the figures 3a, 3b, 3c; and in the explanation of Prof. Hall's Report, p. 174, nothing is said of the locality or the stratigraphical position of this fossil. The plate was drawn by Mr. F. B. Meek, who has put it under the head of *Cretaceous*."

He even goes on to intimate that I had either myself, or in connection with another party, added the figures of this fossil to Mr. Conrad's report, without his knowledge or consent; and that too (as he thinks) under a wrong name, and in a wrong place. He also quotes a letter of Mr. Conrad's in such connection as to convey the impression that Mr. Conrad intended to intimate the same thing. Thus he says, "desirous to know the opinion of Mr. Conrad on this incomprehensible and doubtful proceeding, I wrote him, and give below his answer:"—

"Philadelphia, January 25th, 1861.

JULES MARCOU, Esq.

Dear Sir. When I drew up the report in Emory's Survey, I was shown by Prof. Hall a series of *Gryphæa*, some of which were undoubtedly your *G. Tucumcarii* as figured on plate XXI. Prof. Hall thought they graduated into *G. Pitcheri*, and I thought so too at that time. The name of your species ought not to have been placed as a synonym to plate VII, figure 3, for it is undoubtedly *G. Pitcheri*.

But the figures on plate XXI, represent a species and specimen, the locality of which is *unknown* to me, and were engraved *after* I had sent in my report and descriptions, so that I cannot now say that I do know whether *G. Pitcheri* is identical with your species or not.

The locality of the *G. Pitcheri* (page 155 Leon Springs, Texas; Plains of Kiamesha, Arkansas; New Braunfels, Texas; Fort Washita and Cross Timbers, Texas;) are correctly given from MSS. accompanying the specimens.

. . . . Sincerely yours, T. A. CONRAD."

Having had nothing whatever to do with the Mexican Boundary Report, excepting to draw the fossils figured in it, while all my drawings were on separate pieces of Bristol board, none of which were arranged on the plates by me;—and having had no agency whatever in deciding which figures should be arranged under the head of Cretaceous or otherwise,—I knew it was utterly impossible that Mr. Conrad could have even suspected, when he was writing his letter quoted above, the nature of the construction Mr. Marcou would place upon it. Consequently on seeing Mr. Marcou's paper I wrote Mr. Conrad on the subject, and received the following reply:—

"Trenton, June 21, [1861.]

My Dear Sir,—I am surprised that your name has been introduced in reference to the Palæontological report in Emory's Boundary Survey. You certainly had no connection with it other than drawing the plates, and never, that I know of, expressed an opinion of any species named in that report. When I said that *G. Tucumcarii* ought not to have been placed as a synonym to plate VII, fig. 3, I meant that *I* should not have done so, as I was not entirely satisfied of the identity of *G. Pitcheri* and *G. Tucumcarii*. I alone am responsible for the error, if there be one. I either made the reference myself, or authorized Prof. Hall to make it in my name. The figure on plate XXI, to the best of my recollection was engraved *after* I had sent in my report, but no one excepting myself is responsible for omitting any reference to it in my report.

Truly yours, T. A. CONRAD.

In a postscript to this letter Mr. Conrad also states, amongst other things, that he is now satisfied that the so-called *G. Tucumcarii* is the

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typical form of Morton's Cretaceous *G. Pitcheri.* The following are his words: "by-the-by, Gabb showed me specimens which convince me that *Tucumcarii* is the original form of Morton's *G. Pitcheri.*"

So it will be seen that what Mr. Marcou calls "the mysterious appearance of this beautiful fossil" under the head of Cretaceous, in Mr. Conrad's report, is not, after all, so "incomprehensible and doubtful" a matter as he had supposed.

Mr. Conrad's latest opinion, after examining additional specimens that the so-called *G. Tucumcarii* is the typical form of Morton's *G. Pitcheri*, and that his own *G. Pitcheri* var. *navia*, (that is, the narrow form Dr. Roemer and Mr. Marcou referred to *G. Pitcheri*) is probably a distinct species, is in exact accordance with my own views expressed as long back as 1858. Mr. Gabb has also arrived at the same conclusion;* and when it is borne in mind that he and Mr. Conrad have at Philadelphia Morton's original specimen, and an extensive series of the *Gryphæas* of various ages from Texas and Arkansas, for comparison with Mr. Marcou's figures, drawn as he states by one of the best artists in Paris, the impartial reader will readily understand the value of their opinion on this point.

Mr. Marcou lays great stress upon the differences between the so-called *G. Tucumcarii*, and the narrow form formerly referred by him to *G. Pitcheri*, as if this has some bearing on the question at issue in regard to his Pyramid Mountain Jurassic. Whether we regard these forms, however, as distinct, or only as varieties of one species, has no bearing whatever on the main question at issue, since it is well known, as has been shown by Dr. B. F. Shumard, that they are both Cretaceous, and occur together in the same bed in Texas along with the so-called *Ostrea Marshii*, and numerous well marked Cretaceous fossils. Dr. S. has also shown that undoubted Cretaceous genera and species also occur in Texas, far beneath the horizon of the *Ostrea* and *Gryphæa*, Mr. Marcou supposed to belong to the Jurassic.

In regard to Mr. Marcou's efforts to explain away these facts, and to show that Dr. Shumard is in error as to the order of succession of the Texas formations, it is unnecessary for me to say a single word, as that geologist is abundantly able to defend his own views.

That Jurassic, and possibly Triassic rocks occur in New Mexico and other portions of the southwest, is very probable, but what Dr. Shumard, Dr. Newberry, Mr. Conrad, Mr. Gabb, myself and others maintain is, that the fossils relied upon by Mr. Marcou to prove the existence of the Jurassic at Pyramid mountain, are Cretaceous species; and consequently that he has included Cretaceous strata in his Jurassic. We have undoubted Jurassic fossils from the Black Hills in Nebraska, and from a few other points on the north Platte above Fort Laramie, as well as from some places in Utah, but they all differ widely from those referred by Mr. Marcou to that epoch, and hold a much lower stratigraphical position. No Jurassic fossils have yet been found in the country west of the Mississippi, south of Utah, so far as my knowledge extends, unless some remains of plants, and large Saurian bones discovered by Dr. Newberry in New Mexico, belong to that epoch; and these came from the red beds far below the horizon of Mr. Marcou's supposed Jurassic fossils.

I remain, yours truly, F. B. MEEK.

Washington, D. C., July 27, 1861.

* Proceed. Acad. Nat. Sci. Phil. Feb. 1861.

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2. *Note on Mr. Lesquereux's Table of Comparative Sections of Coal Measures.* (To the Editors of the Am. Jour. Sci. and Arts.)—Throughout the notice of the Kentucky Geological Survey, published in the July number of your Journal, my name is perhaps liable to be confounded with that of my brother Joseph Lesley, Jr., to whom is due whatever credit belongs to the Topographico-geological report of the margin of the eastern coal field of Kentucky.* As in this notice, quotations from my friend Mr. Lesquereux refer several times to my little Manual of Coal and its topography, published in 1856, I trust that you will permit me a word or two in relation to its exhibition of the Pennsylvania measures. The sections referred to in the Manual are most of them from ten to twenty years old, and were offered as illustrations of principles, not as guides to local geologists. They were meant to exhibit the general scheme of the Coal Measures; but neither settled the principal questions mooted among us, nor embodied late discoveries. One of these is of such importance that I wish to call special attention to it here, as I have done once already at the Montreal Meeting of the American Association.

It will be noticed in Mr. Lesquereux's "Table of Comparative Sections" accompanying your notice, and in the first two columns representing the Kentucky Coals, that a group of beds, four in number, seem to be represented in the other columns by only one bed, the Pennsylvania Pittsburg bed.

Five years ago I made a careful survey of the Coal series in Somerset County, Pennsylvania, especially of its upper and middle part. I found here a group of beds, one of which was the Pittsburg bed, exactly like the group No. 9, 10, 11 and 12 of Western Kentucky, with the Anvil Rock in character above it. The group consisted of three large beds, ten, twelve and sixteen feet thick respectively, with intervals of fifty and sixty feet between them; and, with these, just under the Anvil Rock, was a fourth and smaller bed. I have never had time to write out for publication my notes of this survey, nor indeed of any of my surveys; but no region that I have examined is more worthy of description, because of the flagrant representation which it makes of the persistency of our coal beds over a region at least seven hundred miles wide from east to west; affording a satisfactory demonstration, that the middle Kentucky area, or Cincinnati Axis as we used to call it, has been denuded of the same coal measures, deposited in the same order, and of about the same thickness as now exist at widely separated points on both sides of it; namely, at the summit of the Alleghany Mountain and at the mouth of the Tennessee river. I have always considered the theory of the dying out of the coal-beds and intervening rocks along the western outcrop of the S.E. Ohio and E. Kentucky coal area to be contrary to sound and wide geological views. I have always doubted or disbelieved the few local data supposed to favor that theory, drawn from the vicinity of Greenup County, Kentucky. My own observations at Hanging Rock were against it. My brother's very

* Peter Lesley, the author of a "Manual of Coal and its Topography," and one of the original corps of Assistants on the Pennsylvania Geological Survey in 1839—has since 1848 written his name J. P. Lesley—No careful reader of the notice alluded to on p. 118 need be perplexed in distinguishing between this gentleman and his accomplished brother Joseph Lesley, Jr., author of the Topographical Geological Report of Kentucky.—Eds.

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complete survey of the outcrop across the whole State of Kentucky shows nothing of it. On the contrary, everywhere along the great escarpment line of the Ohio, Kentucky and Tennessee outcrop, denudation reigns supreme as limiting the coal area westward, without observable assistance from nonconformability. And certainly the exact agreement of the great group of upper beds and Top Rock of Somerset County, Pennsylvania, with the great upper group and Anvil Rock of Western Kentucky, must convince every geologist that one continuous coal area stretched from the head of the Potomac to the mouth of the Tennessee, when the Pittsburg bed and its group were made. I am happy to say that in this faith I agree with Mr. Lesquereux.*

There are some other points which I wish to touch on while occasion offers. My friend Mr. Lesquereux wishes to suppress the name False Coal Measures. I agree with him. I never liked the term. I used it because there was no other. In fact no other has been suggested, except in connection with some whole nomenclature, such as Mr. Rogers's Vespertine coal. But then it has a well-known meaning, and is understood by everybody. Geologists always talked of the Coal Measures. But a day came when a whole series of carboniferous rocks were discovered not belonging to the Coal Measures, and in fact thousands of feet below the acknowledged base of the Coal Measures. These rocks had deceived everybody, and would still deceive many. They were therefore rightly called at first False Coal Measures. Geologists will recall how completely they deceived the Nova Scotia geologists, even into inventing an extraordinary theory of lagoons and back deposites. They still exist, and they must have some name. They are still deceptive. What shall we call them?

But Mr. Lesquereux is not even in favor of acknowledging their existence as a separate series. He wishes to include them in the Coal Measures. He says the distinction is invalid, because it is based upon the fact that they are not generally found over the whole extent of the coal-fields of America. I think my friend is wrong. He underrates their extent. And then again the distinction, I take it, is not based upon horizontal considerations but upon vertical ones; based upon the immense interval between the two series as observed along their Alleghany mountain outcrops. He will recollect that at the head of the Juniata up the gorge of Tipton Creek, there are two open gangways in what are probably *two* coal-beds three feet thick, *six hundred feet below the great conglomerate* at the base of the Coal Measures. At Augusta Springs in Virginia, and from Blacksburg and Christiansburg southwestward through Wythe County, Virginia, there are False Coal Measures beneath at least two thousand feet of Red Shale and limestone, and how much more cannot be told because of the vicinity of those immense faults which bring up lower Silurian rocks against the coal. Now these False Coal Measures are surely an independent system; and as such they correspond with a similar independent system in Europe. I believe my friend Mr. Lesquereux has determined their independence also by at least one fossil plant which he has never seen above the Red Shale; that is in connection with the True Coal Measures. This system although to all appearance, full 1500 feet lower in the series than the Tipton coal, cannot be considered other than above it; inasmuch as the Red Shale is only about one hundred feet

* See his paper in this Journ., vol. xxviii, pp. 28, 29.

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thick at Tipton, and just beneath the conglomerate. But we may easily imagine that the Tipton coals are the actual representatives of the Virginia system, by considering the thousand feet of Red Shale of the latter to be a lithological enlargement, southward, of the Tipton Red Shale, at the expense of the five hundred feet of Tipton green sandstones which do not appear above the Virginia coals. But there is still another series to be spoken of.

Between the False Coal Measures and the True Coal Measures by which I mean the carboniferous system above a supposed persistent conglomerate stratum, (now however known to be a variable group of sand rocks, shales and coals), there is what might and what would be called a third coal system, if the conglomerate proved to be a universal horizon rock. For underneath the conglomerate, and at the top of the Red Shale, formation XI, (Rogers's Umbral), lie alternations of carboniferous, argillaceous and siliceous shales, containing at least one real coal-bed. This appears everywhere beneath the conglomerate or the sand-rocks at the base of the Coal Measures.

The question for my friend Mr. Lesquereux to settle for us is this:—Whether the coal systems under the conglomerate in eastern Kentucky, as described in my brother's report and shown in his long section, is this sub-conglomerate system of Pennsylvania, and is perhaps also represented by the low Mercer and Trumbull County coals in the Lake Erie district, at Massillon, &c.;—or whether it is the Wythe and Montgomery County sub-red-shale False Coal Measures of Virginia;—or whether it is the reappearance in Kentucky of the Tipton Juniata coal-beds at a still lower horizon;—or whether it *represents all these* in a general thinning out of the Devonian and sub-carboniferous, westward, from the massive outcrops of the Alleghany.

I am sorry that I cannot agree with my friend Mr. Lesquereux when in continuing his argument against the name False Coal Measures he says that "the same [objection that they do not extend over all the coal region] can be said of the coal strata between the Mahoning and the Anvil Rock sandstone, and particularly of the upper Coal Measures above the Anvil Rock." I have already adduced the Somerset County coals to demonstrate the contrary respecting the Pittsburg group of beds (between the Mahoning S.S. and the Anvil Rock); and it seems to me that the contrary is equally clear respecting the group of beds above the Anvil rock; for these beds exist in Green and Washington counties, Pennsylvania, along the Monongahela river, six hundred miles away from the West Kentucky coalfield; and I believe them to exist in the Pottsville Anthracite basin. I sympathize heartily with my friend Mr. Lesquereux in his dislike to the erroneous depths which have been assigned to the Anthracite Measures. But I fear I cannot go all lengths with him in this dislike, when, if I understand his language, he makes the Pottsville basin so shallow as to contain only four nominal coal-beds, or rather the equivalents of the beds from the Kentucky coal No. 4 downwards. This must be a very great mistake, which I think Mr. Shæffer or any other geologist in that region can demonstrate without trouble. If Mr. Rogers has repeated and endorsed the old blunder of separating the Mammoth and Jugular Veins, thereby duplicating the lower part of the meas-

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ures in the Pottsville basin, and has also given by far too much latitude in his measurements to the faulty condition of the middle of the basin, the incredible thickness of the measures which he thereby obtains should not drive us to the opposite extreme. Now when Mr. Lesquereux says: "from palæontological evidence I am satisfied that the highest coal of the Pottsville and Tamaqua basin is the equivalent of our No. 4, and that the measures do not ascend higher in that part of Pennsylvania," he merely destroys the value of palæontological evidence to the eyes of those of us who have been so long and so lovingly and reverently watching his footsteps on our mountains, bringing us glad tidings of a new science. He certainly forgets that at Shamoken he can count twelve great beds of coal from below upwards, and then can lay his hand upon a conglomerate, which if lithological laws are of any value, must some day prove to be very near his Anvil Rock. He must not forget that even in the shallow synclinals of the Lehigh mountains he has a greater depth of coal than he here assigns to the wide and deep Pottsville and Tamaqua basin. He must not forget that the sharp mountain exhibited to him in every one of its gaps, a row of vertical coal-beds, long enough to more than include the sub-Anvil rock group. It seems as well demonstrated as the absence of fossils will permit it to be, that we have in the middle folds of this great anthracite basin, in either the group of the Salem vein, or of the Peach Mountain, the representatives of the super-anvil-rock coals of western Kentucky, and of the Green and Washington County coals of southwestern Pennsylvania.

In a letter just received (Aug. 20th) Mr. Lesquereux informs me that when last in Pottsville, Mr. Schaffer and other gentlemen, coal proprietors, assured him that the Salem, Gate, and Tunnel veins, which in the face of every opposition he had always identified, were now found to be in fact the same, or belonging to the same group. In that case we must permit him certainly to place them in as low a botanical position as he has. This will not invalidate the series made out from the northern and undisturbed flank of the basin, along the Mine Hill. It will leave, in fact, the basin as deep as any in the United States.

My friend thinks and says, with the enthusiastic confidence of a master in palæontology, which he is,—in fact our great master in the botany of the coal,—that we structuralists can do nothing to help the great questions of East and West to a solution; that "it is only by palæontology that the equivalency of the coal strata has been and can be established in distant parts of the same basin, and especially in separate coal basins." If this be said exclusively of the drift-covered basins of the far west, it is reasonably true; but when stated broadly and made therefore applicable to the whole coal area it is surely unacceptable. Palæontological identification is certainly the crowning glory of our science, the *abendröthe* of our working day, and the reward we receive for patient toil in one department by finding at the far end a door thrown open for us into a new and finer one. But let every tub stand upon its own bottom. Palæontology and Lithology must learn to live and let live. My friend's botanical conclusions are some of them yet to be modified by structural examinations; as in fact they were reached through structural observations. The patient tracing of outcrops from ravine to ravine, and from county to county; the patient

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construction and comparison of cross sections on hillside after hillside, until not an exposure has escaped; the patient triangulation and levelling of area after area until a perfect map of the surface has been obtained; and the patient underground working up of gangways and breasts, tunnels and shafts, which reveal blunders no surface exhibitions could have corrected:—What is the best palæontological work in comparison with all this—*for results?* What is even the patience, the skill and the genius of Lesquereux, for a life-time, to a combination of apparatus and opportunity so overwhelming and complete? The "comparative sections" in the table were all constructed with the very slightest references possible to palæontological evidence. The Freeport-Curlew limestone and the Ferriferous limestone are great *lithological* horizons, entirely established by lithological and structural geology.

The opinion expressed by my friend Mr. Lesquereux "that coal No. 1, with its members B and C, and perhaps No. 2 subdivides, forming as many as eight different strata," is an evidence how little structural difficulties appall palæontologists. To my mind, filled with the experiences of twenty-five years in coal, such a thing is simply incredible. So far as my observation has covered the ground, no coal-bed is known to separate permanently into two or more unless it is essentially a double or triple bed; that is, unless it evidently consists, at the points where it seems to be but one bed, of two or more, by virtue of persistent interlaminations of fire clay, or some equivalent rock. I have never seen an exception to this rule. The great bed of the lower anthracite coal is a permanently triple bed, and therefore its members are sometimes separated by twenty or thirty feet of slate. The great Mauch Chunk Summit Mine Coal is, even to the uninstructed eye, a group of beds, spreading somewhat further asunder elsewhere. But that any one of the small western bituminous coals should first so separate in parts as to obtain regularly lettered or numbered "members" and then these again split up until the one bed should be represented by a tall cross section containing eight separate beds of coal—I cannot easily believe it.

In conclusion I wish to suggest to geologists who take a special interest in the carboniferous formation, that the term Mahoning sandstone has become as unsafe a name for a horizon line, as is the term Conglomerate. My surveys for the Pennsylvania Railroad Company some years ago, in Indiana, Fayette and Westmoreland Counties, made me aware of several important rocks in the Barren Measures by which that whole group, (and I must still consider it an *interval* separating most decidedly the upper and lower divisions of the true Coal Measures), can be discussed intelligently. One of these rocks is a conglomerate of weight and character, appearing over a considerable country, and forming as I believe, as general a horizon as any eminent sand-rock can. It underlies the Pittsburg coal-bed one or two hundred feet; overlies the red bands of the Barren Measures; forms the coping rock along the centre of the Ligonier valley north of the Conemaugh, and crowns with cliffs the ravines of Castleman's river, in southern Somerset, above the Turkey-foot. For a long time I confounded it with the Mahoning sandstone, the true place of which is from one to three hundred feet further down. But I afterwards learned to distinguish and value it apart.

J. P. Lesley.

Philadelphia, Aug. 1, 1861.

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3. *On the origin of some Magnesian and Aluminous Rocks;* by T. STERRY HUNT, F.R.S., of the Geological Survey of Canada. (From the Canadian Naturalist for June, 1860.)—In common with other observers, I have long since called attention to the fact that silicates of lime, magnesia and oxyd of iron are deposited during the evaporation of many natural waters, such as the mineral springs of Varennes and Fitzroy, and the waters of the Ottawa river. I have also suggested that the silicates thus produced may have contributed in a considerable degree to the formation of rocks. (This Journal, March, 1860, p. 284). A hydrous silicate of magnesia which approaches in composition to $MgO\ SiO^2$, combined with from ten to twenty per cent of water, and mechanically mixed with small portions of oxyd of iron, alumina and carbonates of lime and magnesia, forms extensive beds with limestones and clays in tertiary strata, in France, Spain, Morocco, Greece and Turkey. It is the sepiolite of Glocker, the meerschaum of some authors, the magnesite of others. The quincite of Berthier, which occurs in red particles disseminated in limestone, is a similar compound, containing some oxyd of iron. The sepiolite from the basin of Paris occurs beneath the gypsiferous group, and in the lacustrine series known as the St. Ouen limestone, where it forms very fissile shaly layers, enclosing nodules of opal (menilite). The structure of this sepiolite, which I have examined and described as above, and that from Morocco, which is used by the Moors in their baths as a substitute for soap, and has been described by Damour, is peculiar. The mineral is made up of thin soft scales, and when moistened with water, swells up into a pasty mass resembling a finely divided talc. Although agreeing closely with this mineral in the proportions of silica and magnesia, sepiolite contains more water, and both before and after ignition is soluble in acids, which talc is not. We cannot however doubt that talc and steatite have been formed from sepiolite, which has undergone a chemical change and become insoluble. It is possible that serpentine may be derived from another silicate richer in magnesia than sepiolite. The frequent association of carbonates of lime and magnesia with talc, and of carbonate of magnesia, talc and serpentine, as in the ophiolite of Roxbury (This Jour., [2], xxv, 224,) would seem opposed to the notion that serpentine may have been formed from the alteration of a mixture of sepiolite and carbonate of magnesia. In chlorite, which often forms rock masses almost without admixture, we have an alumino-magnesian silicate which cannot have been derived from sepiolite, inasmuch as this contains for the amount of magnesia present, twice as much silica as chlorite. The oxygen ratios of the silica and magnesia in sepiolite are as 3 : 1, and those of silica, alumina and magnesia (including the variable amount of ferrous oxyd which in part replaces the latter) in chlorite are as 6 : 3 : 5, while in the purest clays the ratio of silica and alumina equals 1 : 1, and in most argillaceous sediments the proportion of silica is still greater. It is evident, therefore, that chlorite could not be formed from a mixture of sepiolite with clay, or even with pure alumina, without the elimination of a large amount of silica, and we are led to regard it as having been generated by the reaction of a silicate of alumina or clay with magnesia, which was probably present in the unaltered sediment in the form of carbonate. Unless indeed the process, which according to Scheerer, has in recent times caused the deposition from waters, of

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neolite, a hydrous alumino-magnesian silicate approaching to chlorite in composition, be the type of a reaction which formerly generated beds of chlorite, in the same way as those of sepiolite or talc.

A silicate of lime allied to sepiolite, has not so far as I am aware, yet been noticed among unaltered sediments, and among crystalline strata calcareous are more rare than magnesian silicates, although double silicates of lime and magnesia (pyroxene and hornblende,) often form beds, and wollastonite, either alone or mingled with carbonate of lime, sometimes constitutes rock masses. The double silicates of alumina and lime are however abundant; the lime-feldspars, scapolite, epidote (saussurite), and white garnet, all form beds in crystalline rocks. Reactions in water at the earth's surface, and at no very elevated temperature, may have given rise to double silicates of lime and alumina corresponding to neolite, and allied in composition to the zeolites, and these by subsequent metamorphism have been changed into anhydrous silicates. The production of harmotome, chabazite and apophyllite by the waters of a spring at Plombières, at temperatures not above 160° F. as observed by Daubrée, lends probability to such a view.

But while we admit the possible direct formation of double silicates in water at ordinary temperatures, there is not wanting evidence that the reaction which we long since pointed out, (Proc. Royal Society of London, May 7, 1857, this Jour., [2], xxv, 287), between silicious and argillaceous matters and earthy carbonates in presence of alkaline solutions, intervenes in the metamorphism of sedimentary rocks and in the production of many silicious minerals. The blue Silurian limestones of the island of Montreal, when treated by acids leave an insoluble residue, which contains about ten per cent of soluble silica, mixed with an argillaceous matter whose analysis gave silica 73·0, alumina 18·3, potash 5·5, and only traces of lime and magnesia. In the vicinity of an intrusive dolerite, however, the limestone is changed in color, and leaves by the action of acids a greenish matter, which consists of silica 40·2, alumina 9·3, peroxyd of iron 5·2, lime 36·6, magnesia 3·7. The free silica and that of the intermingled aluminous silicate, has thus been saturated with protoxyd bases, still, however, retaining the alumina in combination. A similar reaction with more aluminous matters, would give rise to epidote, garnet, magnesian mica, scapolite or feldspars like labradorite and anorthite, and it is not impossible that in such reactions a portion of alumina may sometimes be set free, and give rise to corundum, spinel, diaspore or völknerite.

In the ordinary modes of decomposition of minerals containing alumina, this base separates in the form of silicate, and the conditions required for its elimination in a free state are but imperfectly understood. We have elsewhere pointed out the decomposition by alkaline and earthy carbonates, of solutions of sulphate of alumina or native alum, as one source of free alumina, and insisted upon the existence of pigotite, a native compound of alumina with an organic acid, as an evidence that this base is sometimes like oxyd of iron, and oxyd of manganese, (this Jour., [2], xiii, 12), taken into solution by water aided by organic matters. A hydrate of alumina, gibbsite, is found associated with limonite, and the aluminous minerals from the south of France described by Berthier and Deville, show that free alumina is much more common in

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nature than was formerly supposed. Berthier long since gave the name of bauxite to an earthy pisolitic ore which occurs either massive or imbedded in limestones of tertiary age, at Baux, and many other localities in the departments of Gard and Var, and also in Calabria, and the Grecian Archipelago, forming in some places an abundant rock.* This substance is a variable mixture of a hydrate of alumina, apparently approaching diaspore in composition, with hydrous peroxyd of iron, sometimes constituting a workable iron ore, and at other times a veritable ore of alumina. It contains besides small portions of silica, titanic, vanadic and phosphoric acids, and occasionally encloses grains of corundum. A compact dark red variety gave Deville, alumina 57·6, peroxyd of iron 25·3, and water 10·8, besides 3·1 of titanic acid, and 2·8 of silica. In other specimens the proportions of alumina and iron oxyd are nearly equal, or the latter predominates, as in one example where the proportions were 48·8 of iron oxyd, and 32·2 of alumina; and another, 60 of iron, and 18 of alumina and titanium. In these analyses the carbonate of lime, generally present, was first removed by a dilute acid; the prolonged action of stronger acids completely dissolves the hydrated oxyds. By an intense heat this substance is converted into crystalline corundum, resembling emery in its physical character, but the presence of grains of corundum in the hydrated mineral seems to show that this transformation may take place at ordinary temperatures. The emery of Greece and Asia Minor, which is associated with variable proportions of oxyd of iron, is according to Dr. J. Lawrence Smith always more or less hydrated.

The argillaceous matter enclosing some varieties of this bauxite or impure diaspore, is white, without plasticity, and very rich in alumina; one specimen freed from the red ferruginous portions, gave alumina 58·1, silica 21·7, peroxyd of iron 3·0, titanium 3·2, water 14·0. This substance approaches in its composition to collyrite, and to the dillnite which is the gangue of the diaspore of Schemnitz. These materials however contain from 20 to 40 per cent of water. Scarbroite, schrötterite, and allophane are similar matters; the latter, unlike a clay in its structure, appears to have been deposited from solution. The subsulphate of alumina, known as websterite or aluminite, is often met with in layers and concretionary masses in Tertiary clays,† and is sometimes mingled with a silicate having the composition of allophane. This frequent occurrence of alumina still retaining a portion of sulphuric acid, confirms the view which we have elsewhere expressed, that solutions of native alums have by their decomposition furnished the alumina for many of the minerals in question, while the conditions under which this base is taken into solution by organic matters, still require investigation. The careful examination of unaltered sedimentary deposits, is calculated to throw great additional light upon the origin of the crystalline rocks.

4. *Note to the Paper of Messrs. Meek and Worthen on the Age of the Goniatite Limestone*, p. 167 of this No.—The name "Kinderhook Group" is now proposed by these authors to include the beds lying between the Black Slate and the Burlington Limestone, which have heretofore been considered the equivalents of the Chemung Group of New York. This designation will be observed in the Illinois Report.—(*Letter to Editors.*)

* Deville, *Ann. de Chimie et Physique*, (3) lxi, 309.

† In this connection we may notice apatelite, a basic persulphate of iron, which occurs in conditions similar to aluminite.

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III. BOTANY.

1. *Martius, Flora Brasiliensis.*—Since our last notice, two more issues of this great work have come to hand: viz., fascicles 25 and 26, containing the *Santalaceæ* (two species of *Thesium*) and *Myristicaceæ* (26 species of *Myristica*) by Alph. DeCandolle, and the more numerous *Apocynaceæ*, which are thoroughly elaborated, with decided talent, by DeCandolle's curator, J. Müller, from whom excellent work may be expected, judging from this specimen. This was published in July, 1860. It is now followed by fascicles 27 and 28, published in February last. This contains the *Antidesmeæ* by Tulasne, consisting merely of three species of *Hieronymia* (the *Stilaginella* of Tulasne), the representatives of *Antidesma* in the new world, the group pretty clearly belonging to *Euphorbiaceæ;* also the *Begoniaceæ* by DeCandolle (83 species of *Begonia*), followed by a few pages of interesting disquisition by Von Martius himself. Finally we have the *Celastrineæ*, *Ilicineæ*, and *Rhamneæ*, by S. Reissek of Vienna, copiously illustrated, and with the leaves of many species self-printed by the Vienna process. The elaboration of these orders appears to be very satisfactory. We congratulate Von Martius upon the character and steady progress of this formidable work. A. G.

2. *Floræ Columbiæ terrarumque adjacentium Specimina Selecta*, edidit H. Karsten, Tom. I, fasciculus primus. Berol: F. Dümler, 1858. pp. 42, tab. 1–20, col. imp., fol.—This promising commencement of a magnificent work has just reached us, with an advertisement by the successors of the original publisher, dated Feb. 1859, announcing that the publication, if the subscription warrants, will extend to ten such fasciculi, issued at intervals of six months; the price of each, with colored plates, twenty Prussian thalers; the uncolored copies, fifteen thalers. We trust the needful patronage will not be wanting. The plates are very fine, and with satisfactory analyses; and are accompanied each by two pages of letter-press; the characters in Latin; the detailed descriptions and remarks in the German language. The subjects are well chosen; the first representing two new Palms, species of Klopstockia from the Quindiu Andes; the second a Tree-Fern, *Cyathea ebenina* from near Caracas; eight others representing species of *Cinchona* or near relatives of this most important genus, and three others illustrate Rubiaceous genera, *Poggendorffia rosea* seems to be a good *Tacsonia*. The pretty Cobæaceous *Rosenbergia penduliflora*, t. 14, with long ligulate lobes to the corolla and extremely long filaments, is in Fendler's Venezuelian collection, No. 468. A. G.

3. *Journal of the Proceedings of the Linnæan Society*, (Botany), No. 20, (1861) finishes Hooker and Thompson's precursory account of the Indian *Cruciferæ*, and contains five other papers; four of them very short ones, and of only local interest. Dr. Welwitsch's letter on the botany of Benguela, Western Africa, gives an account of a very queer dwarf tree, found near Cape Negro, the stem of which, "with a diameter often of four feet, never rose higher above the surface than one foot, and which through its entire duration, that not unfrequently might exceed a century, always retained the two woody leaves which it threw up at the time of germination, and besides these it never puts forth any other.

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The entire plant looks like a round table, a foot high, projecting over the tolerably hard, sandy soil, the two opposite leaves, (often a fathom long, by 2 to 2½ feet broad) extend on the soil to its margin, each of them split up into numerous ribbon-like segments. The flowers are hermaphrodite and collected in a sort of aments or strobiles." There has also appeared a *Second Supplement* to the botanical portion of vol. v, (1861) which contains four very interesting papers, viz:

(1.) The Natural Order *Aurantiaceæ*, with a Synopsis of the Indian Species, by Daniel Oliver, the newly appointed Professor of Botany in University College, London, who here takes rank as a first-rate monographer.

(2.) Notes on *Menispermaceæ*, by George Bentham, who now, as botanists will be pleased to learn, occupies the presidential chair of Brown and Smith in the Linnæan Society. That the so-called opposition of the parts of the flower in *Menispermaceæ* and *Berberidaceæ* is only in seeming, must we suppose be every where understood and admitted. As to the opposition of stamens to petals in *Rhamneæ* and the like, if shut up to the alternatives mentioned by Mr. Bentham, we should still prefer "the idea of a common origin" to that of the stamen being developed in the axil of the petal, which would introduce a needless and most improbable complexity into the morphology of the flower. But a third alternative, which was long overlooked, appears to offer a more natural explanation, conformable with the laws of the arrangement of leaves, viz., that the stamens are here normally superposed just as the parts of the successive cycles of alternate leaves are,—the ordinary alternation of floral parts being really the thing to be accounted for.

(3.) Notes on *Tiliaceæ*, and 4, Notes on *Bixaceæ* and *Samydaceæ*, by the same author, are masterly papers. At the first view we were far from satisfied throughout with the proposed re-arrangements, but the more we consider the matter the better we like it, even in the association of *Cochlospermum* and *Amoreuxia* with *Bixa*. We should still prefer the union of the *Sanydaceæ* with the *Bixaceæ*, and make less than Mr. Bentham does of the difference between hypogynous and perigynous insertion,—a difference often obscure or shading away, and as often coëxisting in the same natural group, or among closely related ones, as parietal and axile placentation do. No one knows this better than the sagacious authors of the forthcoming new Genera Plantarum; but their adhesion to the old tradition is compelled by their determination "to maintain the Candollian series in its general features,"—which is certainly still desirable; but if rigidly followed out in this respect will certainly do much violence to natural affinities, perhaps without securing adequate practical advantages. But it is far easier to interpose objections than to collocate the natural orders upon any consistent system. A. G.

4. *Calluna vulgaris and Aira caryophyllea in the United States.*—That "America has no Heaths" is a botanical aphorism. It is understood, however, that an English surveyor nearly thirty years ago found *Calluna vulgaris* in the interior of Newfoundland. Also that De la Pylaie, still earlier, enumerates it as an inhabitant of that island. But this summer, Mr. Jackson Dawson, a young gardener, has brought us specimens and living plants (both flowering stocks and young seedlings)

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from Tewksbury, Massachusetts, where the plant occurs rather abundantly over about half an acre of rather boggy ground, along with *Andromeda calyculata*, *Azalea viscosa*, *Kalmia angustifolia*, *Gratiola aurea*, &c., apparently as much at home as any of these. The station is about half a mile from the State Almshouse. Certainly this is as unlikely a plant, and as unlikely a place for it to have been introduced by man either designedly or accidentally, as can well be imagined. From the age of plants it must have been there for at least a dozen years; indeed, it had been noticed and recognized, two years ago, by a Scotch farmer of the vicinity, well pleased to place his foot once more upon his native heather. So that even in New England he may say, if he will—as a friend of ours botanically renders the lines—that

> "*Calluna vulgaris* this night shall be my bed,
> And *Pteris aquilina* the curtain round my head."

It may have been introduced, unlikely as it seems, or we may have to rank this Heath with *Scolopendrium officinarum*, *Subularia aquatica*, and *Marsilea quadrifolia* as species of the Old World so sparingly represented in the New, that they are known only at single stations,—perhaps late-lingerers rather than new-comers.

Aira caryophyllea has just been detected by Wm. M. Canby, Esq., in New Castle county, Delaware, growing very abundantly, "in a dry piece of ground, rather open, but dotted over with pine trees (*Pinus inops*), and completely surrounded by a forest. It certainly has not been ploughed for ten years, probably not for a much longer time. In company with it was *Polygala Nuttallii*, *Sorghum nutans*, &c., but no clover, timothy, or any of the grasses usually cultivated. Still we suppose this species to have been introduced. A. G.

IV. ASTRONOMY AND METEOROLOGY.

1. *The recently discovered Asteroids.*—In the last No. of the Journal we gave a list of the asteroids discovered since 1858, together with the elements of several of them. We now give the elements of the remainder, and also corrected elements of Titania:

Berlin mean time.	(61) Titania, 1861, Jan. 0.2512.	(67) Asia, 1861, April 21.0.	(68) Leto, 1861, June 1.0.
L	38° 8′ 17″·29	241° 22′ 41″·4	240° 24′ 9″·1
π	98 28 35 ·33	294 23 27 ·4	346 15 37 ·5
Ω	191 57 53 ·02	202 0 6 ·5	44 49 43 ·5
i	3 34 21 ·46	5 48 36 ·9	7 58 19 ·8
e	0·1847205	0·144085	0·185692
μ	958″·43568	958″·418	767″·637
a	2·393109	2·393 14	2·774 81

Berlin mean time.	(69) Hesperia, 1861, May 13.4864.	(70) Panopea, 1861, June 0.0.
L	160° 52′ 5″·0	253° 11′ 36″·7
π	117 14 2 ·3	299 3 0 ·2
Ω	186 52 56 ·0	48 21 0 ·3
i	8 28 55 ·7	11 14 37 ·1
e	0.1779006	0.223545
μ	661″·260	813″·222
a	3·064905	2·670127

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In the above tables,

L represents the mean longitude of the planet at Epoch.

π " the longitude of the perihelion.

Ω " the longitude of the ascending node.

i " the inclination of the orbit to the ecliptic.

e " the eccentricity of the orbit.

μ " the mean daily motion.

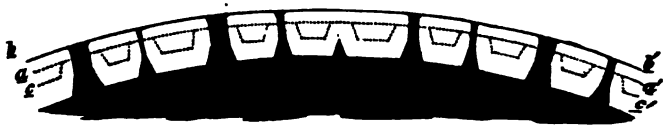
a " the semi-major axis of the orbit.

2. *Note Explanatory of Baily's Beads;* by EDMUND BLUNT.—We have received from Mr. Blunt the following satisfactory illustration of the cause of the formation of beads and ruptures of the ring, etc., in an annular eclipse of the sun. Although privately circulated, this explanation of Baily's Beads has not before been published.—*Eds.*

Brooklyn, N. Y., May 18th, 1854.

Mr. F. Baily concludes his paper, on the Annular Eclipse, May 15, 1836, thus, "That mountains may occasionally obtrude themselves to our view, there can be no question; but it requires further explanation why almost all of the remarkable distortions take place when observed near the edge of the Sun's disc, and as the Moon advances thereon, these prodigious elevations, in a great measure, disappear." The following is an explanation: (Fig. 1.)

1.



Let the line $a\,a'$ represent the true edge of the Sun's disc, and the exterior line $b\,b'$ the apparent edge, (the difference between the two being caused by the tremulous motion in our own atmosphere,) the zig-zag line $c\,c'$ the true edge of the Moon, and the dark the apparent edge, when seen on the Sun—the difference between the two being caused by the same.

Now, as the true edge of the Sun's disc touches any of the mountains on the Moon's edge, if the part in contact is *more* than twice this difference, dark lines will instantly shoot out and connect the apparent edges

2.



of the Sun and Moon, and they become wider as the Moon's edge approaches the exterior edge of the Sun's disc, beads being formed between, or narrower, as the Moon's edge recedes internally, until they break. Fig. 2 shows Baily's Beads at the instant of formation.

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Fig. 3 shows the Sun's lower cusp as seen through an inverting telescope at New York, May 26, 1854.

3.



The following reasons, for the truth of this theory, I beg you to look at:

1st. The observed diameter of the Sun is always greater than the computed. See observations at various observatories.

2d. The diameter of objects projected on the Sun's disc are less than the computed diameters.

3d. Results, obtained from observations at the beginning and end of an eclipse are good; because the contact or end is not seen, except when the Moon's edge touches the true edge of the Sun's disc.

4th. Results obtained by the measurement of the distance of the solar cusps, &c., are not good, and, I think, it is entirely owing to their not correcting the angle, for increase caused by tremulous motion in our own atmosphere, and which amount might be estimated, or even measured during the eclipse, by each observer.

April 13th, 1860.

In addition to the above, I would remark that the annular eclipse, as observed September, 1838, in Brooklyn, showed the truth of this theory. The slow tremulous motion of the atmosphere causing the lines and beads to assume wavy shapes, the Sun's altitude, at the formation of the ring, being low. When the tremulous motion of the atmosphere is so rapid that the wavy lines do not appear, the shooting out of the black lines is almost instantaneous.

The truth of this theory, I tested in the following manner:—At the distance of about eleven miles, was placed a black-board, six feet by eight inches, with a hole in it, two-tenths of an inch in diameter, for the Sun's rays to be reflected through, towards me, with a heliotrope. Towards noon, when the atmosphere was tremulous, a large bright light only was seen, and, as the atmosphere became more steady, the size decreased, until the board began to show as a large faint shadow, which increased in intensity as it decreased in size, and at last showed the board well defined, with a bright point in the centre. The A. M. observations showed the same, but in reverse order.

The eclipse of July 17th (1860) will give an opportunity for observing these distortions, but it will be useless to look for them should there be any moisture, or even a slight mist in the atmosphere, extending over the earth's surface near the observer, as the Sun's diameter at such times, is not increased.

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3. *Meteoric Observations, April* 20, 1861.—The following observations at New Haven show no recurrence of the meteoric shower of April 20, 1803, but they are too limited to be satisfactory. The shower may perhaps continue only a few hours, and thus be easily lost even if observers were watching throughout the globe.

Saturday, April 20, 1861. Observers: Mr. Edward R. Sill and myself. Sky clear; moon down. Different meteors observed:

$2^h\ 45^m$ to 3^h A. M.	in N. 4	S. 6	
3^h " 4^h "	" 13	" 29	

Of these about ten equalled in brilliancy stars of the first magnitude, but none were very remarkable. The majority appeared to come from near the zenith, about the constellation *Lyra*, but they did not show any decided radiant.

On the Monday morning previous, watching alone from $3^h\ 15^m$ to $4^h\ 15^m$, I saw only three or four shooting stars. E. C. Herrick.

4. *Meteoric Observations, August* 10, 1861.—(1.) *New Haven, Conn.*—At this place, the sky was clouded during the nights of Thursday and Friday, Aug. 8 and 9, 1861. The night of Saturday, the 10th, was clear and favorable. From the top of the tower of the Alumni Building, the following observations were made that night by a corps of four observers, viz. Messrs. Charles Tomlinson, Henry P. Johnston, Willabe Haskell, and myself. We were so stationed as to see as many as possible of the meteors, and yet some were undoubtedly lost. None were reckoned twice.

	N.W.	N.E.	S.E.	S.W.	
Aug. 10–11, 10^h to 11^h P. M.	22	26	16	12	= 76
11^h to midnight,	23	33	21	17	94
0^h to 1^h A. M.	23	38	29	29	119
Total seen in 3 hours,					289

Of these shooting stars the large majority moved in paths which traced back would intersect near the sword-handle of Perseus. Many equalled or surpassed in brightness stars of the first magnitude, and one at $11^h\ 30^m$, near the zenith, was much more splendid than Venus and left a train of sparks which remained luminous for twenty seconds after the meteor disappeared. This grand meteor was also seen at Providence, R. I., and was fortunately so well observed by Mr. B. V. Marsh at Burlington, N. J., that it will probably be practicable to ascertain its elevation, length of path and velocity.

Prof. A. C. Twining, of this city, observed here independently Aug. 10th and Aug. 11th, and will probably publish his results.

Watching alone from $8^h\ 30^m$ to 10^h P. M. of the 10th, I saw about 20 shooting stars, several of which were brilliant and accompanied by trains. There was, as heretofore noticed, a gradual increase of numbers from evening to morning.

(2.) *Burlington, N. J.*—Observers: Messrs. Benj. V. Marsh and Samuel J. Gummere. The observers, one looking S.W. and the other N.E., were stationed on the top of a house, but the view was somewhat impaired by obstacles. The sky was nearly clear until after midnight, when clouds began to appear in the South and Southeast. After 2^h they caused seri-

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ous embarrassment, and by $2^h\ 45^m$ the sky was so nearly overcast that the observers retired. Different meteors observed:

1861.			N.E.	S.W.	
Aug. 10–11,	$10^h\ 25^m$ to	11^h P. M.	20	20	= 40
	11 "	12 "	29	29	58
	12 P. M. "	1 A. M.	47	38	85
	1 A. M. "	2 "	35	29	64
	2 " "	2 45 "	28	14	42
					289

Mr. Marsh, who was looking towards the N.E., writes: "At first I could not fix the radiant definitely, most of the tracks pointing to Perseus, but a number to Cassiopeia. Towards midnight it seemed to be very clearly within the triangle formed by η, γ, and τ Persei. I could not detect any change of position afterwards. We thought that seven-eighths of all we saw during the night were conformable. * * * Much the finest meteor seen was at $11^h\ 23^m$,—a most splendid specimen; its track remained visible twenty seconds or more."

Mr. R. M. Gummere, also at Burlington, N. J., watching independently, observed shooting stars as follows, viz:

Aug. 10,	$10^h\ 25^m$ to	11^h P. M.	34
	11 "	12 "	29
	12 "	1 A. M.	37

The night of Aug. 9–10 was stormy at Burlington.

(3.) *Natick, Mass.*—Observers: Messrs. F. W. Russell and E. L. Pray. The night of August 9th was cloudy and rainy. The night of the 10th was clear until about 2 A. M. of the 11th, when about a third of the sky was obscured by clouds. Between 8^h P. M. and $3^h\ 15^m$ A. M., the two observers saw 397 different shooting stars, as follows:

Aug. 10–11.			N.E.	S.E.	N.W.	S.W.	
8^h P. M. to	9^h P. M.		16	5	5	3	= 29
9 " "	10 "		10	2	2	8	22
10 " "	11 "		32	6	5	17	60
11 " "	12 "		28	13	3	30	74
12 P. M. "	1 A. M.		27	12	7	13	59
1 A. M. "	2 "		26	14	27	8	75
2 " "	3 "		14	27	12	8	61
3 " "	3 15 "		4	4	1	8	17
							397

During this period only about one-half the sky was under observation; and from 2 to 3 A. M. not more than half the sky was clear. Only four very large ones were noticed, twenty about the size of Jupiter, one leaving a luminous train of smoke for eight seconds, and the remainder quite small. The radiant, to which two-thirds of the meteors conformed, was a spot about three degrees in diameter, around *beta Persei*.

The foregoing observations show that the meteoric sprinkle of August occurred this year (1861), with the usual characteristics. The number may have been somewhat diminished, but was still very much above the average of ordinary nights. This average is greater than is usually supposed, and the actual number varies greatly on different nights. On

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the night of July 3, 1861, four observers here saw in the hour ending at $10^h\ 5^m$ P. M. *thirty-six* shooting stars, or about half as many as are seen during the corresponding hour on the 10th of August.

It is to be hoped that observers, situated from 50 to 100 miles apart, will hereafter act in concert on the nights of meteoric abundance, so that in case of meteors remarkable for magnitude or other peculiarity, data may be obtained for determining their astronomical elements. E. C. H.

5. *Remarkable Rain-Fall in Ohio.*—(Extract of a letter from S. B. McMillan, dated East Fairfield, O., Aug. 15, 1861, to the Editors). "The same day (Aug. 12th) witnessed the greatest fall of rain ever recorded in this part of the State, in an equal time.

From noon to 1^h P. M.		there fell	0·32 in.	rain.
" $4^h\ 30^m$	" to $5^h\ 30$ P. M.	"	1·40 "	"
" $6^h\ 30$	" 9^h "	"	2·85 "	"
" 9^h	" 11^h "	"	3·44 "	"
Total,			8·01 "	" in 11 hours;

6·29 *inches of which fell in four and a half hours.*

This maximum rain-fall existed over at least 100 square miles. Few dams or bridges are left standing along the streams in this county (Columbiana)—many sheep, cows and horses were drowned, four or five dwelling houses were swept to destruction. The dead bodies of four persons of respectability, and the only persons known to have been drowned, were found the second day after the rain several miles below where the dwelling house in which they were swept away was crushed in pieces. In the village from which it was taken the water was seven feet higher than ever before known, reaching to the second story of nearly every house in the town. There was almost no wind here and only a moderate amount of lightning. A heavy wind is reported 30 miles east of here and also at Cleveland and Sandusky, where it did much damage."

6. *Rain following the discharge of Ordnance;* (note to the National Intelligencer, July 25, 1861.)—Messrs. Editors: In October, 1825, I took note of a very copious rain that immediately followed the discharge of ordnance during the celebration of the meeting of the waters of Lake Erie and the Hudson, upon the completion of the Erie canal; and in 1841 I published my continued observations on the subject, which, to my mind, fully established the fact that the discharge of heavy artillery at contiguous points produces such a concussion that the vapor collects and falls generally in unusual quantities the same day or the day following.

The early battles of the late war between the French, Sardinians, and Austrians were succeeded by such copious rains that even small rivers were not fordable; and during the great battle of Solferino a storm arose of such fierceness that for the time the conflict ceased. Within the last two weeks McClellan's columns on the upper Potomac fought four different battles on as many days, and there were extensive rains before the close of each day. July 21st the great battle of Bull Run, Virginia, was fought, and next day (22d) the rain was copious all day and far into the night. * * * * J. C. Lewis.

A more exact collection of such data as Mr. Lewis has here grouped may lead to important results equally in theory and practice.—Eds.

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V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake on the Island of Penang.* (In a letter to the Editors, dated U. S. Naval Observatory, Washington, 24th August, 1861.)—*Gentlemen:*—Mr. Geo. E. Tyler who has just returned from the East Indies, communicates to me the following:—

"*Saturday, Feb.* 16, 1861.—At 7½ P. M. there was a severe earthquake shock of sufficient force to throw down crockery from shelves, stop clocks, and to set articles to swinging. In walking, the ground seemed to undulate sufficiently to make many persons feel nausea. There appeared to be three distinct shocks, each of which seemed to pass from North to South and to continue 30 seconds.

"*March 2d.*—I have learned since the above, that the shock was felt at Malacca and Singapore at the same time at each place and with about the same degree of violence, though it was not recognized by many vessels in the harbors and on the passage here from Singapore.

"About five minutes before the shock, there was an unusual commotion in the sea and I spoke of it to others at the time. There was no perceptible air stirring, and the sky was clear. Thermometer 91° Fahr. No other earthquake has been known here during the last 17 years and then only a very slight one." Very respectfully yours,

J. M. Gilliss, *Supt.*

2. *Earthquake at Syracuse, New York.*—The Syracuse Standard of July 12th says: We learn from various sources that a very sensible shock of an earthquake was felt in this city and other parts of the county last evening, about nine o'clock. The weather yesterday very suddenly became quite cold and chilly, an extraordinary change from the intense heat of the previous days. The shock was about four seconds in duration, and was so severe as to cause dwelling-houses to rock, and in some cases furniture was removed and persons sitting in chairs were waved to and fro. Many persons supposed some of the fixtures of their dwellings had fallen upon the floors. A gentleman from the north part of the town of Salina informs us that the shock was sensibly felt in that section, and farmers ran out of doors supposing that their barns or outhouses had fallen.

3. *On the Natural Dissemination of Gold.*—Mr. Eckfeldt the Principal Assayer of the U. S. Mint at Philadelphia, has lately made several interesting examinations tending to show the very wide distribution of gold. Passing over the evidence respecting its presence in various galenas, in metallic lead, copper, silver, antimony, &c., we cite the following:—perhaps the most curious result of all.

Underneath the paved city of Philadelphia there lies a deposit of clay, whose area, by a probable estimate, would measure over three miles square, enabling us to figure out the convenient sum of ten square miles. The average depth is believed to be not less than fifteen feet. The inquiry was started whether gold was diffused in this earthy bed. From a central locality, which might afford a fair assay for the whole, the cellar of the new market-house in Market Street near Eleventh Street, we dug out some of the clay at a depth of fourteen feet, where it could not have been an artificial deposit. The weight of 130 grammes was dried and duly treated, and yielded one-eighth of a milligramme of gold; a very decided quantity on a fine assay balance.

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It was afterwards ascertained that the clay in its natural moisture loses about fifteen per cent by drying. So that, as it lies in the ground, the clay contains one part gold in 1,224,000.

This experiment was repeated upon clay taken from a brickyard in the suburbs of the city, with nearly the same result.

In order to calculate with some accuracy the value of this body of wealth, we cut out blocks of the clay, and found that on an average, a cubic foot, as it lies in the ground, weighs 120 pounds, as near as may be; making the specific gravity 1·92. The assay gives seven-tenths of a grain, say three cents' worth of gold to the cubic foot. Assuming the data already given, we get 4180 millions of cubic feet of clay under our streets and houses, in which securely lies 126 millions of dollars. And if, as is pretty certain, the corporate limits of the city would afford eight times this bulk of clay, we have more gold than has yet been brought, according to the statistics, from California and Australia.

It is also apparent that every time a cartload of clay is hauled out of a cellar, enough gold goes with it to pay for the carting. And if the bricks which front our houses could have brought to their surface, in the form of gold-leaf, the amount of gold which they contain, we should have the glittering show of two square inches on every brick.—*Am. Phil. Society Proceed.*, viii, 273.

4. *Notice of Chemical and Physical Apparatus, by Becker & Sons.*—The Sheffield [Yale] Scientific School has recently procured from Becker & Sons, 54 Columbia st., Brooklyn, N. Y., some instruments of such excellent device and workmanship that we deem it a duty to the scientific community to call attention to them. 1st, An air-pump for laboratory use. This has a single cylinder, the piston of which is solid and has a diameter of 3¼ inches and a seven inch stroke. The communication between the interior of the cylinder and the receiver is opened and closed by means of a two-way cock which is operated by the motion of the pump-handle. The instrument is compact, light, of simple construction but most accurate workanship, and from the absence of valves *is always ready* to furnish a good vacuum with a few minutes labor. It serves also as a condenser, and is adapted for transferring gases. It is the best instrument we have ever seen for the chemical laboratory. It cost $100.

2d. The Balances of Becker & Son, we are also prepared, after considerable experience in the use of those of Oertling, Deleuil and Hugershoff, and after having seen the instruments of nearly every balance-maker of this country and Europe, to pronounce the best known to us. They combine accuracy and delicacy with convenience and cheapness, to a higher degree than any Balances we have hitherto met with. There are now in the Analytical Laboratory here, three of the Becker Balances, viz., an assay balance, which, loaded with 5 grms. in either scale readily indicates $\frac{1}{10}$ of a milligramme, an Analytical Balance carrying 200 grms. in each pan readily indicating $\frac{1}{10}$th miligramme and a Physical Balance which with a load 5 kilogrammes is turned by one centigramme. See advertisement.

3d, A standard and mountain siphon Barometer with inch and millimeter graduations belonging to the Laboratory is a very beautiful and precise instrument.

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The inch employed by Becker & Sons is derived directly from pendulum measurements of their own.

4th, finally, the Engineering Dept. has a Theodolite adapted also as a transit, of most perfect device and construction.

The self-recording meteorological instruments and beautiful aneroids which Becker & Sons have in operation at their *atelier*, are worthy the notice of all physicists. S. W. J.

Book Notices.—

1. *The Mathematical Works of Isaac Barrow, D.D., Master of Trinity College, Cambridge.* Edited for Trinity College by W. Whewell, D.D., Master of the College. Cambridge, 1860. 754 pages, 8vo.—This volume contains the lectures which Dr. Barrow delivered as Lucasian Professor of Mathematics at Cambridge; an office which he held from 1664 to 1670. These lectures consist of three series: the Lectiones Mathematicae, the Lectiones Opticae, and the Lectiones Geometricae; the first being on the general principles of mathematics, the second containing propositions of Optics proved geometrically, and the third treating of properties of Curve lines. The mathematical lectures are twenty-three in number, and were delivered in 1664, 5 and 6, but were not published till 1685.

After these, are given four lectures in which the author proposes to expound the method by which Archimedes invented his theorems concerning Cones and Spheres.

In the Lectiones Opticae, eighteen in number, Dr. Barrow treated of the theory of the foci of spherical surfaces and lenses; and explained the cause of the rainbow, simplifying Cartesius' calculations.

The Sectiones Geometricae, thirteen in number, first published in 1670, are full of curious methods of determining the areas and tangents of curves, many of which are very close anticipations of Newton's methods. The most noted of these is the method of drawing tangents to curves given in Lect. X, Art. 14. This method is justly held to be an anticipation of the Differential Calculus, and to approach very near to it.

Barrow's rule for finding the subtangent of a curve is this: "After constituting the equation to the curve, put $x-a$ and $y-e$ for the ordinates x and y; expand and reject all the terms in which there is no a or e; (for they destroy each other by the nature of the curve;) reject all the terms in which a or e are above the first power, or are multiplied together; (for they are of no value compared with the rest, as being infinitely small;) then put y for a and t the subtangent for e; and the subtangent is found." Barrow applies this method to determine the subtangents of several curves.

In 1669, Newton showed to Dr. Barrow some papers in which the method of fluxions was faintly indicated, and rules given for the rectification and quadrature of curves, and for drawing tangents to curves; and it appears that Newton had been in possession of this method from the year 1666.

In the year 1672, the celebrated Leibnitz communicated to some members of the Royal Society, certain researches relating to the differences of numbers, and in 1674 he announced that he possessed important theorems relative to the quadrature of the circle by series.

In 1676 Newton sent a letter to Oldenburg, which was to be shown to

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Leibnitz, in which he describes the properties of his method of fluxions, as well for the determination of tangents, as the quadrature of curves. In 1677 Leibnitz sent to Oldenburg, to be communicated to Newton, a letter containing an account of his *Differential Calculus*. In 1684 Leibnitz published his new method in the Leipsic Acts; but Newton's method of Fluxions did not become generally known till the publication of the Principia in 1686. Leibnitz is admitted to have been the first to publish to the world the principles of the Differential Calculus; but Newton was unquestionably acquainted with the leading principles of the calculus before they were invented by Leibnitz; and Dr. Barrow had a method of drawing tangents to curves very similar to that furnished by the calculus, before either Newton or Leibnitz had devoted any special attention to the subject.

2. *Results of a scientific mission to India and High Asia undertaken between the years* 1854 *and* 1858, *by order of the court of Directors of the Honorable East India Company, by* HERMANN, ADOLPHE and ROBERT DE SCHLAGINTWEIT. With an atlas of panoramas, views and maps. Volume I. London: Trübner and Co. 1861. 512 pages, large quarto.—This volume contains the astronomical determinations of latitudes and longitudes and the magnetic observations made during the scientific journey of the brothers De Schlagintweit through India and High Asia. One of the chief objects of this journey was the completion of the magnetic survey of India, which had been commenced in 1846, by the late Captain Elliot in the Eastern Archipelago; but in consequence of the high interest evinced in it by the Directors of the East India company, the mission assumed a very general and extensive character. The brothers De Schlagintweit left England Sept. 20, 1854, and arrived in Bombay Oct. 26th. One of the brothers, Adolphe, was killed at Kashgar, in August, 1857;* the other two brothers arrived at Trieste, June 8, 1857. The results of this mission are to be embraced in nine quarto volumes of which the following are the titles:

I. Astronomical and magnetic observations.

II. Hypsometry, Barometrical and Trigonometrical observations.

III. Topical Geography, and Route Book of the Himalaya and Tibet.

IV and V. Meteorology and climate in general.

VI. Geology.

VII. Botany and Zoology, particularly with reference to geographical distribution.

VIII. Ethnography, comparative researches based on measurements, casts and photographs.

IX. Geographical aspects of India, the Himalaya, Tibet and Turkistan.

Volume I, recently received, contains a minute account of the methods of observation and calculation; with full details of the observations for the determination of geographical co-ordinates. The magnetic observations are very numerous, and are reported with great minuteness. These observations embraced the Declination of the magnetic needle; the horizontal intensity; the Dip and Vertical Intensity; and also the total intensity. The instruments employed were those generally adopted in the English magnetic surveys, and the magnetic intensity is expressed in the unit employed by General Sabine, and other English philosophers.

* See this Journal, vol. xxvi, 378, and xxix, 236.

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The following is a summary of the magnetic observations made in the course of this Survey.

In column fourth S. L. signifies that the station was but slightly elevated above the level of the sea.

Results of the magnetic observations.

Station.	Latitude.	Longitude from Greenwich.	Height Eng. feet.	Declination East.	Dip North.	Total Intensity.
Suget,	36° 10′ N.	77° 50 ′E.	12,960	4° 21′·5	50° 12′·35	
Sumgal,	36 8	78 5	13,212		50 5 ·38	10·879
Tso Ka,	35 58	76 3	15,724		49 18 ·92	
Karakorum Pass,	35 46	77 30	18,341	3 33 ·6	49 13 ·75	10·933
Chorkonda,	35 33	75 56	13,790	2 53 ·4	48 43 ·25	
Skardo,	35 20	75 44	7,250	4 5 ·1	48 20 ·52	10·943
Tashing,	35 15	74 40	9,691	4 17 ·7	48 23 ·82	10·751
Sasser Pass,	35 6	77 27	17,753	3 31 ·9	48 17 ·68	
Daver,	34 34	74 46	7,718		47 41 ·65	
Kargil,	34 30	76 4	8,845	3 10 ·1	47 57 ·15	10·197
Dras,	34 28	75 43	9,951		46 51 ·45	10·122
Mozaferabad,	34 22	73 31	2,220	3 23 ·9	47 20 ·00	9·827
Leh,	34 8	77 14	11,527	3 22 ·6	46 52 ·64	10·113
Srinagger,	34 4	74 48	5,144	2 59 ·9	46 58 ·20	9·986
Peshaur,	34 3	71 33	1,250	2 27 ·9	46 25 ·75	10·889
Marri,	33 51	73 22	7,260	3 21 ·1	46 2 ·84	9·633
Tsomognalari,	33 39	78 38	14,010	3 21 ·8	46 34 ·05	9·972
Raulpindi,	33 36	72 59	1,674	3 5 ·5	45 55 ·71	9·904
Padum,	33 28	76 54	11,590	3 40 ·8	45 51 ·97	
Tsomoriri,	32 45	78 16	15,130	3 9 ·9	45 20 ·30	
Kardong,	32 33	77 0	10,233	3 23 ·3	44 28 ·44	10·960
Sultanpur,	31 57	77 5	3,330	3 2 ·6	43 52 ·19	
Mud,	31 55	78 1	12,421	3 43 ·5	44 17 ·33	
Dera Ismael Khan,	31 39	70 56	478	0 58 ·2	44 23 ·47	10·703
Vangtu Bridge,	31 37	77 54	4,210		43 22 ·80	
Labor,	31 34	74 14	790	2 2 ·3	43 17 ·44	9·856
Rampur,	31 31	77 37	3,215		42 46 ·43	
Ussilla,	31 7	78 18	8,940		42 13 ·24	10·960
Simla,	31 6	77 7	7,091	2 55 ·5	42 30 ·00	9·709
Mana,	30 47	79 20	10,670	2 44 ·9	41 25 ·24	10·528
Milum,	30 34	79 54	11,640	2 40 ·3	40 31 ·91	10·489
Massuri,	30 28	77 59	7,549		41 15 ·12	10·807
Ambala,	30 21	76 48	1,026	2 26 ·2	40 48 ·40	
Nainital,	29 23	79 30	6,409	2 28 ·2	38 33 ·71	9·856
Shikarpur,	27 55	68 51	60		36 2 ·00	9·892
Aligarh,	27 53	78 3	760	1 37 ·3	36 58 ·90	
Kathmandu,	27 42	85 12	4,350	2 35 ·8	37 34 ·24	8·734
Dibrugarh,	27 32	94 57	395	0 46 ·4	38 30 ·35	9·882
Falut,	27 6	87 59	12,042	2 24 ·8	36 54 ·96	8·316
Darjiling,	27 3	88 15	7,168	2 48 ·0	36 32 ·97	8·152
Tonglo,	27 1	88 3	10,080	2 30 ·5	36 25 ·04	8·539
Narigun,	26 53	92 6	3,615	4 48 ·0	37 8 ·11	9·114
Lakhnau,	26 51	80 55	520	2 37 ·4	35 18 ·55	10·019
Siganli.	26 46	84 44	260		35 40 ·10	
Udelguri,	26 45	91 56	352	2 36 ·3	36 27 ·65	9·624
Tezpur,	26 34	92 46	239	0 22 ·5	37 14 ·93	9·746
Kissenganj,	26 6	87 56	140	2 20 ·2	35 11 ·95	8·187
Gohatti,	26 5	91 43	134	2 0 ·1	35 19 ·15	9·541
Patna,	25 37	85 7	170	1 53 ·9	33 32 ·96	9·215
Benares,	25 18	82 59	325	1 50 ·3	32 41 ·25	9·294
Cherra Punji,	25 14	91 40	4,164	2 20 ·4	33 .7 ·27	9·449
Surajganj,	24 22	89 43	s. l.		32 3 ·50	

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TABLE—(continued.)

Station.	Latitude.	Longitude from Greenwich.	Height Eng. feet.	Declination East.	Dip North.	Total Intensity.
Rampur Bolea,	24° 21′ N.	88° 34′ E.	54		32° 0′·77	7·904
Sager,	23 50	78 43	1,880		29 58·84	
Dhaka,	23 42	90 20	s. L.	2° 21′·2	31 1·23	
Bhuj,	23 17	69 40	283	0 12·0	28 25·00	9·109
Jablpur,	23 9	79 56	1,480	1 10·5	28 31·14	9·863
Kulna,	22 45	89 36	s. L.	2 30·4	29 19·85	
Calcutta,	22 33	88 20	s. L.	2 25·1	28 14·84	9·113
Nagri,	20 25	78 52	850		22 49·99	9·367
Bombay,	18 53	72 49	s L.	0 19·1	19 6·60	8·475
Puna,	18 30	73 52	1,819		19 2·25	
Mahabaleshvar,	17 55	73 38	4,396		16 25·50	
Rajamandri,	17 10	81 46	s. L.	1 24·8	16 23·53	9·197
Kaladghi,	16 12	75 29	1,720	0 30·0	14 27·25	
Bellari,	15 8	76 53	1,580	0 21·0	11 59·68	8·834
Madras,	13 4	80 13	s. L.	0 59·3	7 52·34	8·100
Utakamand,	11 23	76 43	7,278	0 57·0	4 27·32	8·862
Utatur,	11 4	78 51	280		2 50·08	
Galle,	6 2	80 10	s. L.	0 41·0	−7 40·90	8·076

3. *Microscopic Anatomy of the Lumbar Enlargement of the Spinal Cord;* by JOHN DEAN, M.D. (Communicated to the American Academy of Arts and Sciences by Prof. Jeffries Wyman, Nov. 14, 1860.)—This is a paper of great value, displaying extensive and patient research in a very important but little cultivated department of anatomy. This indefatigable investigator of the nervous system has confirmed the discoveries of J. L. Clarke, published in the Transactions of the Royal Society, 1859, and added other important discoveries of his own.

Our limits do not permit us to give even a synopsis of this valuable paper but we cite the following account of the author's method of preparing sections of the spinal cord for microscopic examination:

"The method of preparation usually employed was a modification of Gerlach's and Clarke's although many others were employed, according to the object in view. The following method gave the best results from which to make drawings. Thin sections from the cord, hardened in alcohol, were washed a few minutes in pure water, and then immersed in glycerine, to which Gerlach's solution of carmine (solution of carmine in water to which a few drops of strong ammonia have been added) previously filtered, had been added; in this the sections were allowed to remain from four to eight hours according to the tint desired (a light tint interfering least with the details and sharpness of outline). I have been able to obtain more delicately colored specimens and more clearly defined structure by the use of glycerine than by any other method. The sections are then washed first in pure water, afterwards with strong alcohol, in which they are allowed to remain about an hour, and are now ready for preparation with turpentine according to Clarke's method; [*i. e.*, to lay them on a slide and drop on turpentine from time to time until the alcohol is replaced by turpentine] they may be put in Canada Balsam, or, as I have found very advantageous, in thick, colorless copal varnish, which often preserves minute details better than balsam. Although Stilling and others have found much fault with Clarke's method of preparation, on account of the too great transparency it sometimes gives, I am convinced

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that, with practice and some slight modifications, it is the only one suited to the minute study of the cord, other methods seeming to me, after thorough trial, quite unsatisfactory as compared with Clarke's. As a hardening material, I have often employed chromic acid with considerable advantage; but when coloring matter is used, alcohol is most suitable, and is certainly much easier to succeed with."

4. *Summary of Medical Science;* edited by WALTER S. WELLS, M.D. 304 pages. 8vo. New York, Charles T. Evans.—This is an epitome of Medical Literature selected from European and American Medical Journals, including also original articles, to be issued semi-annually. The arrangement and design of this work will make it a valuable repertory of the current views of the medical profession, especially to those who are not supplied with a very large variety of medical periodicals.

5. *Report on the Geology and Agriculture of the State of Mississippi;* by EUGENE W. HILGARD, Ph.D., State Geologist. Jackson, Miss., 1860. 8vo, pp. 391, accompanied by a Geological Map and Sections.—This Report, announced in our last, is a valuable contribution to our knowledge of the Cretaceous and Tertiary strata which cover by far the larger portion of the surface of Mississippi. We had marked for extract the remarks of Dr. Hilgard on the general relations of these two great groups of strata, as unfolded in his Report, but want of space compels us to postpone their citation now. The Geological Map of Mississippi which accompanies the Report is a valuable addition to our knowledge of the exact tendencies of the several formations in this State, made more valuable by the profiles of the Mississippi formations which are given. We hope to notice some points (both Geological and Agricultural) in this report again.

6. *First Biennial Report of the progress of the Geological Survey of Michigan*, embracing observations on the Geology, Zoology and Botany of the Lower Peninsula, made to the Governor, Dec. 31, 1860. Lansing, 1861. 8vo.—A fragment only of the complete Report (270 pages) has reached us. It is a satisfaction to see the work resumed in Michigan which Houghton so well began many years ago. In glancing at the Chapter on Peat, which occurs abundantly in Michigan, we see no allusion to the valuable researches of Prof. Johnson made for the Connecticut State Agricultural Society, the agricultural value of which is such as to entitle them to special notice. When the complete Report reaches us we shall resume our notice.

BROCHURES.

ZOOLOGICAL AND ANATOMICAL.—

On the Rhizopodal Fauna of the Mediterranean, compared with that of the Italian and other Tertiary deposits. By T. RUPERT JONES, Esq., F.G.S., and W. K. PARKER, Esq., Mem. M.S. 1860. 8vo, pp. 16.

Synopsis of American Cretaceous Brachiopoda. Proc. Acad. Nat. Sci., Jan. 1861. By W. M. GABB.

On the genus Raphidophora, Serville; with descriptions of four species from the Caves of Kentucky, and from the Pacific Coast. Bost. Soc. Nat. Hist. By SAMUEL H. SCUDDER.

Synonymy of the Cyclades, a family of Acephalous Mollusca. Part 2. By TEMPLE PRIME. Proc. Acad. Nat. Sci. Phil., July, 1861.

Croonian Lecture.—On the Arrangement of the Muscular Fibres of the Ventricular Portion of the Heart of the Mammal. By JAMES PETTIGREW, Esq.

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GEOLOGICAL.—

Documents anciens et nouveaux sur la faune primordiale et le Système Taconique en Amérique. Par M. J. BARRANDE. With two plates.

Notes on the Cretaceous and Carboniferous Rocks of Texas. By JULES MARCOU. Boston, 1861.

On the Occurrence of Flint-implements, associated with the Remains of Animals of extinct species in beds of a late geological period, in France at Amiens and Abbeville, and in England at Hoxne. By JOSEPH PRESTWICH, F.R.S., F.G.S., etc. London, 1861. 4to, pp. 40.

On the supposed identity of the Paradoxides Harlani, Green, with the Paradoxides spinosus, Boeck. By ALBERT ORDWAY.

On the Fossils brought from the Arctic Regions in 1859, by Captain Sir F. L. M'Clintock. By the Rev. SAMUEL HAUGHTON, M.A., etc.

On Cyclostigma, a new genus of fossil plants from the Old Red Sandstone of Kiltorcan, Co. Kilkenny; and on the General Law of Phyllotaxis in the Natural Orders,—Lycopodiaceæ, Equisetaceæ, Filices, etc. By the Rev. SAMUEL HAUGHTON, etc.

On the Discovery of some Fossil Remains near Bahia in South America. By S. ALLPORT, Esq.

On the Structure of the Northwestern Highlands, and the relations of the Gneiss, Red Sandstone, and Quartzite of Sutherland and Ross-shire. By JAMES NICOL, F.G.S., F.R.S.E., etc.

Address delivered at the Anniversary Meeting of the Geological Society of London, on the 15th of February, 1861; prefaced by the announcement of the award of the Wollaston Medal and proceeds of the Donation-fund for the same year. By LEONARD HORNER, Esq., F.R.S. L. & E., President of the Society. London, 1861.

MISCELLANEOUS.—

Report made to the Navy Department by the Board of U. S. Naval Engineers, to determine the relative economy of using steam with different degrees of expansion. Washington, 1861. 8vo, pp. 38.

Publications of Isaac Lea on Recent Conchology. Bibliography. January 1, 1861.

Report of the Trustees of the Museum of Comparative Zoology, 1861. Boston, 1861.

The Second Annual Report of the Trustees of the Cooper Union for the Advancement of Science and Art. January 1, 1861. New York, 1861.

New York State Agricultural College, Ovid, Seneca Co., N. Y.—Charter, Ordinances, Regulations and Course of Studies. 1861. Albany, 1861. 8vo, pp. 16.

The Theory and Art of Bread-making. A new process without the use of Ferment. By E. N. HORSFORD, Rumford Professor in Harvard University, Cambridge. 1861.

Catalogue of Telegraph Material, manufactured by Charles T. & J. N. Chester, 104 Centre Street, New York. With Appendix. New York.

Appendix to Messrs. Stevenson's Answer to Sir David Brewster's Reply regarding Dioptric Lights. By D. & T. STEVENSON, Civil Engineers. Edinburgh, 1860.

Reply to Professor Tyndall's Remarks, in his work "on the Glaciers of the Alps," relating to Rendu's "Théorie des Glaciers." By JAMES DAVID FORBES, D.C.L., LL.D., F.R.S., etc. Edinburgh, 1860.

Voyage d'André Michaux en Canada. Depuis le Lac Champlain jusqu'a la Baie d'Hudson. Par O. BRUNET. Quebec: Bureau de l'Abeille. 1861.

PERSONAL.

Correction.—In our notice of the death of Dr. Robb, p. 150, his name was incorrectly given as CHARLES—it was JAMES; and his labors in his chair commenced in 1837, not as stated in 1827.

LORING W. BAILEY, Esq., late of Harvard College—has succeeded to the chair made vacant by the death of Dr. Robb in the University of New Brunswick, at Fredrickton, N. B., British N. A.

The numerous friends of the late Prof. J. W. Bailey of West Point Military Academy, whose memory is so warmly cherished by all who knew him, will rejoice to welcome to the active walks of science a son who in kindred branches of investigation has already shown marked ability, and to know that he has already achieved so honorable a post.

P. S. *Sept. 2d.*—The telegraphic report of an earthquake at Louisville, Cincinnati and other central parts of the United States, reaches us at this moment. Will correspondents in the affected district send us their observations?

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXXIV.—*Physical Aspects of the Comet II*, 1861; by Commr. J. M. GILLISS, Supt. U. S. Naval Observatory.

THE comet was first noticed on the evening of the 30th of June at 10½ o'clock. At that time a bank of clouds obscured the nucleus, and its lengthened coma of pulsating light extending towards the zenith caused it to be mistaken for an auroral beam. This opinion of its nature was apparently confirmed by a number of luminous and vapory flocculi lying eastward of the meridian, and near the prime vertical. The following evening at about the same hour or a little later, it was again remarked, and under somewhat similar circumstances; but whilst the change of place was evident, there was no reason to suspect it a celestial body. At a later hour its character was no longer doubtful.

On the night of the 2d of July, the nucleus of the comet was near the small star 6 Ursæ Majoris, from which point the tail proceeded in two branches. The first one slightly curving towards the star α Ursæ Majoris, was only 8° or at most 10° in length. The other, eastern or main branch, was straight and narrow, and passed in nearly a vertical direction closely parallel with the stars λ and ν Draconis, near the latter of which it was the most attenuated, and not more than 1½° in width. Thence, spreading gradually, it could be followed by the eye to a point in the neighborhood of 68 and 72 Herculis, or to a distance of some 80° or 85° from the nucleus. During the night it seemed to move slowly westward, finally enveloping the two stars of Draco mentioned above.

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Its light was neither uniform nor constant. For the first 8° or 10° from the nucleus the tail was remarkably brilliant, and then its light rapidly diminished in intensity until reaching its narrowest point, beyond which the gradation was almost insensible. The constancy of the light near the nucleus was interrupted at intervals by flashings or pulsations, closely resembling those of the aurora, and at these times it was remarked that the upper portion of the tail was perceptibly fainter, though this may have been simply the optical effect of contrast.

When viewed with a telescope of low power, the nucleus appeared as a small planetary disc of only a few seconds diameter. From this there emanated towards the sun a luminous sector, or fan-shaped head, terminated by a well-defined convex line. The matter proceeding from the nucleus toward the sun and forming the head, was at this line sharply repelled, and falling back on either side, formed the branches of the tail. The whole appearance of this sector, at first brilliant and well-defined, underwent various modifications as the night progressed. When first observed, it was nearly symmetrical with respect to the comet's axis. The eastern wing was perhaps a little the longer of the two. There was a dark oval spot near the middle of the fan and a little to the east of the axis: then a faint curved line or lines, concentric with the outer convex boundary, divided the mass into upper and lower strata, each with a cusp on either side. Afterwards the lines appeared broken, giving a mottled appearance to the central zone of the sector, and finally the western cusps seemed to break, and the fan-shape was transformed into a spiral whose centre was in the nucleus. Meanwhile, during the hours of observation, the dimensions of the whole mass had increased to at least double of the original size, while the outlines had become so indistinct that it was only with difficulty the general shape could be recognized.

July 3.—The nucleus was distinctly visible to the unassisted eye as early as 8 P. M., and as late as $4^h\ 10^m$ on the following morning. It might have been seen at even a later hour.

In the field of the telescope used last night, (the comet seeker), by 9 o'clock it was a brilliant stellar point just north of 35 Ursæ Majoris. In the equatorial it was enlarged to 11″·2, and was evidently elongated in a line perpendicular to the direction of its motion.

The luminous sector, or fan-shaped head preceding it had greatly changed. Four measurements placed its outer boundary line at 101″ from the nucleus. This line was parabolic rather than elliptical, but there was in its western half an irregularity as though a segment had been cut from that wing. In the early part of the evening, the posterior boundary was curved on each wing of the sector, its eastern half terminating in a sharp cusp,

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whilst the western one was not only irregular, as has been said, but its extremity was not as well defined, and the volume of that half was sensibly less. That boundary had notably flattened by $11^h\ 45^m$.

The surface of the sector was much less mottled than during the night of the 2d, and was at no time so vivid as then. The dark oval spot could not be recognized. Beyond the sector there was a dark space, and concentric with and at the distance of 896″ (measured by Mr. Ferguson) from the nucleus, a faint outer envelope was traceable. This last was a narrow band of dusky white hue, densest directly in front of the nucleus, at which point it was 12″ or 14″ broad, and from thence diminished towards the extremities of the wings both in volume and luminosity until its form was that of a slender crescent.

The coma continued much as last night, and requires comment under two heads. The lower, or main portion, extending from the nucleus to half-way between κ and λ Draconis, was markedly the brighter, and the upper part of it slightly turned to the westward. Its eastern edge, bordering close on κ, and passing to the left of λ, was best defined; its western more fringe-like and spreading from the axis. It was not, at any time, as brilliant as during last night, nor was the dark central line near the axis as marked, but was, as then, subject to fitful pulsations, at which periods the increase of light sometimes seemed wholly confined to within 12° or 14° of the nucleus, at others to flash to the utmost extremity of the coma almost instantly, and again at others, the whole volume appeared to be bent to the westward as a willow branch by the wind. The most remarkable of these pulsations occurred at $10^h\ 50^m$, during which the coma became extremely faint between κ and α Draconis, though it continued quite distinct above the latter star. Its greatest breadth did not exceed 4°.

α Draconis was near the axis of the longer and narrower portion. This was nowhere more than 1½° broad; was always faintest between κ and α Draconis, above which it was brighter, and could be followed in its gradually diminishing lustre to the eastward of α Ophiuchi where it was lost in the light of the milky way.

July 4.—The gazing observations of this night continued from $7^h\ 50^m$ until $11^h\ 30^m$, P. M.

At $7^h\ 55^m$ the cometary nature of the body was readily distinguishable, and the light of the nucleus had become visible before that of α Ursæ Majoris. When seen at a later hour it was more condensed than last night, and appeared in the comet seeker as a brilliant elongated star.

At $10^h\ 50^m$ the general form of the sector-shaped head preceding the nucleus was parabolic. It was less distinctly marked

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than during the last night. Its greatest extent from the nucleus by a mean of five measures in the direction of the axis of the comet was 140″, and in a line perpendicular thereto—the extremity of the east wing—about one-third greater, or 180″. The outline of the western half was broken as it was last night, and the surface of that wing was much mottled. 10° or 12° to the westward of the axis, and forming an angle of 45° with it, there emanated a narrow brush of light which was traceable in the field of the equatorial for 30″. The posterior edge of the sector was again curved as on the night of the 2d, that of the eastern half being an unbroken line, whilst the western one was quite irregular. Moreover, there was a fan-shaped bundle of rays to the latter, which shot from the nucleus to a distance of 18″ or 20″ in a line perpendicular to the axis of the sector.

The outer envelope so well seen on the night of the 3d could not be traced in the equatorial, and was perceptible in the field of the comet-seeker only at intervals and by indirect vision. It preserved its slender crescent outline and was concentric with the sector, but separated from it by a dark space of about 70″.

At $9^h\ 7^m$ the coma was plainly divisible into two branches of which the bifurcation was just above $\varkappa$ Draconis. The angle at which the western branch curved from the longer one was from 3° to 4°. The great volume of the light was of a delicate cream color, and was within 8° of the nucleus, from which it gradually diminished in brilliancy. The eastern edge was the best defined, but neither of them was sharp, and the western one was more brushy, and curved outwardly more than heretofore. Above the point of separation of the two branches, the western one spread into quite a broad fan-shape whose outer borders rapidly diminished in light as far as the line joining α Draconis and ζ Ursæ Majoris; and except during the occasional pulsations, it wholly faded from sight within five degrees upward from that line. During these periods, the curve could be traced to the cluster of stars near θ Bootis. The great bend of the curve was on or near the line joining δ Ursæ Majoris and $\varkappa$ Draconis. A dark space intervened between its eastern line and the eastern branch of the coma.

α and ι Draconis and τ, σ, η and ε Herculis were all within that branch. This nowhere above α Draconis exceeded $1\frac{1}{2}$° in breadth. It gradually diminished and again increased in brightness between the last named star and ι of the same constellation, and could be followed to the scattered light of the milky way east of α Ophiuchi. The periodical fluctuations in its brightness were not so remarkable as on either of the other evenings.

July 6.—Clouds broke away and the comet was found with the unassisted eye at $8^h\ 15^m$; it was obscured with occasional interruptions by clouds until 10^h when the sky became hopelessly overcast.

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The comet was much fainter to-night. The tail was not more than 25° in length, and curved very nearly the same as on previous nights, but was broader, being nowhere less than 3° in width. The western and the main branches seemed both subdivided continually.

The luminosity surrounding the head was more extended than before, but with no perceptible outline.

The sector was much smaller and fainter, and for the greater part of the time could scarcely be discerned at all as distinct from the general mass of light. The vertex of its upper, convex side was some 5° or 10° to the right of the comet's axis, corresponding very nearly to the position of the line or brush of light seen on the 3d inst. The inner edge of the eastern cusp was better defined than that of the western,—it was concave as usual, while the western, when it could be seen at all, was quite straight. There was no trace whatever of any dark spots or lines, except that by occasional glimpses a shade could be suspected separating the outer luminosity from the sector, but even this was very doubtful.

July 7.—Although there were thin cirri extending over all that portion of the sky, the cometary nature of the body was recognizable as early as $8^h\ 5^m$. An hour later, the thin clouds had all disappeared.

At 10^h P. M. the light of the nucleus was brighter than that of ε Ursæ Majoris. With a power of 70, and the full aperture of the equatorial, it was, in comparison with the night of the 5th, condensed and brilliant, but not stellar.

The head, or what has hitherto been called the sector was not unlike an arrow-head in form.

The anterior boundary of the sector was more flattened than on previous evenings, and was not unlike an arrow-head greatly expanded perpendicular to the axis of length. A brush of luminous fibres extended from the nucleus across it, inclined to the west at an angle of 8° or 10°, and perceptible 20″ beyond the boundary. That wing was the smaller, and much the less regular in outline. The curve of the posterior boundary also was more flattened, but neither of them was well-defined, although the night had become perfectly clear.

The western branch of the coma could be traced from the nucleus to near θ Bootis, the eastern one to about a degree beyond υ and φ Herculis, and the latter stars were precisely in its line. At 8° from the nucleus the two were not more than 1½° to 2° broad. The great volume of light was within 10° of the nucleus, and at 20° the brilliancy of the coma did not exceed that of the milky way, west of γ Aquilæ. But its intensity was subject to great changes, when it seemed to flow from the nucleus in a stream steadily increasing for some minutes, and again as

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slowly fading away. At these times the dark space between the two branches of the coma became more distinct, and the optical illusion of a curve in the line of the axis more apparent. The most noteworthy of these changes was just at 11 o'clock, shortly after which hour the observations ceased.

July 8.—The nucleus was more planetary than during last evening, and was approximately of the same degree of brightness, or produced the same effect upon the eye as ζ Ursæ Majoris. It became visible soon after 8^h P. M.

In the equatorial, and with power 70 as used then, the sector head was much more distinct, and its anterior boundary quite circular. The posterior line was a caustic, of which the nucleus occupied one of the cusps. The eastern cusp was sharp, whilst the western continued as irregular as on previous evenings.

The marked brush or rays of light diverging from the nucleus extended across the general mottled surface of the sector at the angle observed last night.

The coma continued in two distinct branches, of which the western one was curved, and constantly traceable to within a degree of θ Bootis. During the pulsations it could be seen a degree or two beyond that point. Its western outline was markedly brushy from the nucleus to extreme visibility. The eastern branch extended to and covered υ and φ Herculis. The great volume of light was within 8° of the nucleus, and its eastern line was the sharpest. Above the point mentioned, the coma diminished in brightness uniformly, until it was no longer distinguishable beyond φ Herculis. As heretofore the dark space between the two branches was most notable during the outward emissions of light from the nucleus through them.

Upon attempting to compute an orbit for the comet, Prof. Hubbard found it impossible to represent the observed path by a parabola, and then obtained by the Gaussian method the following hyperbolic elements, based upon the places obtained by Mr. Ferguson on the 2d, 8th, and 17th of July. They give for the middle date the values $\Delta l = -0''.33$, $\Delta b = -0''.16$.

Time of perihelion passage,	1861, June 11.85294.	Wash. M. T.
Long. of perihelion,	249° 44′ 44″.58	M. equinox,
" " node,	278 59 49 .72	1861·0
Inclination,	85 56 8 .86	
Excentricity,	1·0265470	
Peri..elion distance,	0·7453901	

The following is the list of observations, as far as reduced and compared with the above elements:

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Wash. M. T.		α		c.—o.		δ		c.—o.
	d	° ′ ″		″		° ′ ″		″
July	2·41250	180 48 6·8		+ 2·4		63 12 48·5		+ 1·3
	3·36480	147 56 52·0		+17·9		66 10 2·4		− 0·6
	·38102	148 14 43·1		− 9·5		66 11 49·9		− 4·7
	·63908	152 46 48·8		+24·8		66 34 17·6		− 2·5
	4·36786	164 40 26·8		+18·6		66 54 21·2		− 5·5
	6·37421	187 49 0·8		+ 2·5		64 51 1·7		− 5·8
	8·36769	200 12 23·3		− 0·5		61 50 2·0		− 0·8
	10 53104	207 46 0·2		− 1·4		58 58 55·8		− 9·4
	11·45260	209 59 3·0		+ 2·3		57 56 58·2		−10·2
	12·42192	211 54 9·1		+ 8·9		56 58 12·1		− 7·8
	14·43062	214 56 37·2		+ 7·5		55 14 25·5		− 6·1
	16 37969	217 6 9·6		−13·4		53 52 5·4		+ 5·2
	17·35071	217 58 33·0		− 4·8		53 16 37·0		+ 1·5
	·42154	218 1 58·8		+ 4·2		53 14 13·7		− 3·8
	20·40982	220 9 54·0		+16·7		51 42 28·5		− 3·8
	23 37224	221 44 40·7		+19·5		50 30 17·2		− 9·1
	24 35193	222 11 27·8		+28·1		50 9 26·8		− 9·8
	25 36437	222 37 26·0		+32·5		49 49 15·3		−13·2
	27·37080	223 24 38·3		+36·0		49 12 25·8		− 8·9

From these residuals it is evident that the orbit requires yet some correction, not sufficient, however, it is believed, to change its decided hyperbolic nature.

ART. XXXV.—*A Sketch of the Life and Scientific Services of John Evans, M.D., U. S. Geologist for Oregon and Washington Territories, and of the U. S. Chiriqui Exploring Expedition;* by CHARLES T. JACKSON, M.D., of Boston.

THE labors of pioneer geological surveyors, who visit the unbroken wilderness and scale mountains never before trod by civilized man, thread the mazes of cañons amid the Rocky Mountains, or navigate in frail bark canoes unfrequented rivers with unknown rapids and tangled with fallen trees, are of such an arduous and dangerous nature that only the boldest and most adventurous are willing to undertake or are able to accomplish them.

We look with the same interest on one who has successfully accomplished such feats in behalf of science, as we regard the war-worn veteran who has returned from a successful campaign against the enemies of his country. We know and feel what hardships he has endured, and sympathize with him in his triumphs over difficulties and dangers, while we enjoy with him the fruits of his researches, knowing how dearly they have been acquired. The enthusiastic geologist, thousands of miles away from home, throwing away much needed bread in order to preserve specimens to illustrate the mineralogy, geology, and natural history of the country he explores, kindles in us a profound respect for his self-sacrificing spirit and desire to serve, to the extent of his ability, the cause of science. Scientific explorations, in a

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country infested by hostile savages, require the wisdom, coolness, and intrepidity of an old border warrior to ensure success. To accomplish such feats, and return in safety, was the fortune of the subject of the present sketch, and though, unhappily for his country, he died before his valuable reports had been published, we doubt not the Government will duly make public record of his labors.

Dr. EVANS was born in Portsmouth, New Hampshire, on the 14th of February, 1812, and was son of Hon. Richard Evans, a Judge of the Supreme Court of New Hampshire. He was educated at Andover, Massachusetts, and was in his early manhood employed for a while as a mercantile clerk. In 1831 he removed to Washington, and was employed as a clerk in the general Post Office Department for eight years. He afterwards removed to St. Louis, studied medicine, and received the degree of M.D. at the Medical College of that city. In 1835 he married Miss Sarah Z., daughter of the distinguished architect, Robert Mills, formerly of Charleston, South Carolina, but for many years a resident at Washington. By this marriage he had three sons and one daughter.

In 1847 he was appointed, by Dr. David Dale Owen, to be one of his assistants in his geological survey of the western portion of the Chippewa land district, and accomplished his duties to the entire satisfaction of his employer and the public.

In March, 1851, he was appointed, by the Secretary of the Interior, "to institute geological researches on the main lines of the public land surveys about to be commenced in Oregon," and entered zealously on that laborious duty, exploring the falls of the Missouri to the Flat Head pass, in the Rocky Mountains, and through that pass from the forty-sixth to the forty-ninth degrees of north latitude, and to the Columbia River. The valleys of the Flat Head Lake and Bitter Root rivers were also explored, and he crossed the Bitter Root range of mountains, which are one hundred and twenty miles wide, and explored the country to the Spokane, Clear Water, Snake, Walla Walla, Utillah, John Days, and Falls rivers to the Columbia, and thence to Oregon City.

He collected specimens of all the rocks, minerals, fossils, and soils of those wide spread regions, and forwarded them for description and analysis to some of the most skillful mineralogists, palæontologists, botanists, and chemists of the United States, among whom we may name Dr. Owen, Professors Litton, Leidy, Shumard, and Lesquereux, all of whom were supplied with ample materials for their scientific examination and description. To the author of this paper he sent specimens of rocks for description, and of coals, ores of iron, lead and copper, and a large number of selected soils, and a piece of very remarkable meteoric iron, for analysis.

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Dr. Leidy, he informs us, has furnished no less than ninety figures of mammalian fossils, and the other scientific gentlemen have worked out the problems given them to solve, so that a magnificent foundation is laid for a most interesting and valuable report, embracing the labors of some of the most able naturalists and chemists in this country.

Dr. Evans worked steadily on his report, presented it to Congress, and having had an opportunity to re-visit Oregon and Washington Territories, by consent of Congress withdrew his report for the purpose of adding to it his last researches, and thus making it more perfect. We understand that this labor was performed, and that the revised and completed report is now in the general land office at Washington, awaiting publication, which it is earnestly hoped may not long be delayed.

One of the most interesting scientific discoveries made by Dr. Evans, during his explorations in Oregon, was that of an enormous mass of meteoric iron containing an abundance of chrysolite or olivine imbedded in it. During the Indian war in that region, Dr. Evans ascended Bald Mountain, one of the Rogue River range, which is situated from thirty-five to forty miles from Port Orford, a village and port of entry on the Pacific coast, and obtained some pieces of metallic iron, which he broke off from a mass projecting from the grass-covered soil on the slope of the mountain. He was not aware of its meteoric nature until the chemical analysis was made, but the singularity of its appearance caused him to observe very closely its situation, so that when his attention was called to the subject he readily remembered the position, form, appearance, and magnitude of the mass and manifested the most lively interest in procuring it for the government collection in the Smithsonian Institution at Washington, a duty I doubt not he would have been commissioned to perform had his life been spared.

By the aid of information contained in his letters to me, perhaps some traveler in those regions may be able to find this very interesting meteorite, and I shall therefore transcribe what he says of it. In reply to my inquiry, whether he felt confident he could again find this mass of meteoric iron, he says in his letter of May 1st, 1860:

"There cannot be the least difficulty in my finding the meteorite. The western face of Bald Mountain, where it is situated, is, as its name indicates, bare of timber, a grassy slope, without projecting rocks in the immediate vicinity of the meteorite. This mountain is a prominent landmark, seen for a long distance on the ocean, as it is higher than any of the surrounding mountains. It would doubtless be best and most economical to make a preliminary visit to the locality, accompanied only by the two voyageurs alluded to in my last letter." (Two of the Canadian Frenchmen in employ of the Hudson Bay Company.)

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"Arrangements might then be made with the Indians for its purchase, and the best plan selected for its removal. It would be expedient to procure the men and animals necessary in the Umpqua valley, east of the Coast Range of mountains, as Port Orford at present is quite a small settlement, although a 'port of entry.' The meteorite might be shipped in the California steamer to San Francisco, and from that port in a sail vessel round the Horn to Boston."

Dr. Evans estimates the appropriation required at from two to three thousand dollars.

At the General Land Office and Indian Bureau in Washington, Dr. Evans ascertained that the right to this meteorite "vests in the Indians," the land not yet having been ceded to the United States, and any agreement made with them would be binding, and the United States government could lay no claim to it. Dr. Evans then adds:

"There would not be the slightest difficulty in making an arrangement with the Indians, for I am personally acquainted with their chiefs. The principal chief, 'Old John,' spent several days in my camp of two men, during the height of the war, when it would have been dangerous for less than three or four companies of U. S. soldiers to have passed the same mountains. It would require only ten or a dozen blankets, tobacco, &c., as presents."

"As to the cost of transportation of the meteorite to Port Orford, it is difficult to make an accurate estimate. It is situated in a mountainous region, thirty to thirty-five miles from the coast, and the only access to it is by mountain trails. It might be removed in pieces of from one hundred to one hundred and fifty pounds in weight on pack mules; and accurate measurements made of the whole mass without great expense, say from $1,200 to $1,500. But to remove it entire would either be impracticable or involve great expense, unless indeed a river which passes the base of the mountain (Sixe's River), and empties into the Pacific, should prove navigable for a raft of sufficient size for its transportation. There is water enough, but it is no doubt much obstructed by fallen timber, and may have rapids, which it would be difficult to pass over with such a heavy load. In either mode of transportation my first duty would be to explore this river."

In another letter Dr. Evans says: "As to the dimensions of the meteorite I cannot speak with certainty, as no measurements were made at the time. But my recollection is, that four or five feet projected from the surface of the mountain, that it was about the same number of feet in width, and perhaps three or four feet in thickness; but it is no doubt deeply buried in the earth, as the country is very mountainous, generally heavily timbered, and subject to washings from rains and melting of snow in the spring, so that in a few years these causes might cover up a large portion of it. The mass exposed was quite irregular in shape. * * * *

In another letter Dr. Evans states concerning the meteoric iron:

"The locality is about forty miles from Port Orford, in the mountains which rise almost directly from the coast, only accessible by pack mules. But each mule might carry three hundred pounds weight, and if required

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make several trips, to secure the whole mass. It would, however, be necessary to take along suitable tools, to separate the mass, which might if desirable be adjusted together afterwards. But I should suppose that each institution, which might furnish the funds, would desire a portion of the mass."

The latter remark refers to his proposal to raise the funds from several scientific Societies, in case that Congress should fail to appropriate money for the purpose of procuring the meteorite. The legal proprietorship in it was also inquired about expressly with this view in case Congress should fail to grant funds for procuring this very interesting object of science.*

Every possible exertion was making in Congress, and with the departments at Washington, to induce the government to take measures for procuring this very valuable meteorite, and to cause it to be placed in the museum of the Smithsonian Institution, where it could readily be examined by scientific men, but Dr. Evans death, and the present unhappy state of the country, seem to prevent the realization, for the present, of this enterprize.

Dr. Evans in one of his letters to me writes also:—"Did I ever mention to you the discovery made by me (in 1853) of platinum on the Pacific coast?—A portion of the black sand, collected from the bed of a small creek, yielded 47 per cent, as analyzed and separated by Dr. Litton."

Dr. Evans also states that "on the Western slope of Bitter Root Mts., bordering on the Rooskooski River, a large tributary of the Columbia, I discovered a mountain of iron ore, a surface specimen of which yielded, on analysis, 67 per cent of metallic iron. It is fully equal in richness and, greater in altitude, than the celebrated Iron Mountain of Missouri."

Without anticipating more of the matters, in Dr. Evans' Report, which we hope may soon be published by Government, I may say that, from the specimens examined by me, it is evident that there are vast regions of volcanic origin in Oregon, that trachytes, basalt, lavas, native sulphur, and other materials of igneous origin, were among those sent to me for description or analysis, and there were also specimens of pure rock salt, which the note accompanying the specimen stated was "in great abundance," as also was the native sulphur.

Argentiferous lead ores, and specimens of yellow copper pyrites, were also discovered, besides numerous ores of iron and many tertiary dry coals, before mentioned.

Dr. Evans adds: "Is it not worthy of note in the history of nations, and is it not a great honor to our national Legislature, and the Officers of the

* If the Bald Mountain meteoric iron is like in tenacity and hardness to that of most known masses of similar origin, the dissection of it would prove a task of far more difficulty than seems to have been supposed by Dr. Evans: so great indeed that in our judgment it would be impracticable, to the extent suggested. If its dimensions—which appear to be quite conjectural—are not something excessive (like those of the great Columbia and Brazilian irons) the cost of transporting it entire the moderate distance of thirty or forty miles would certainly be less than that of its dissection. It would not be difficult, with the aid of a good mechanic, to contrive a vehicle which would both raise it from its bed and effect its transport.—Eds.

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General Government, that they should have instituted and completed, a Geological reconnoissance of the vast regions between the Western States and the Pacific Ocean, and from the British possessions to the boundary of California? This survey, exhibiting as it does by careful analyses the constituents of all the prevailing soils, coals, and minerals: and that too whilst the country for the most part is still inhabited by savages!

"Extensive beds of semi-anthracite (or perhaps more properly semi-bituminous) coals, ores of iron, lead, copper platinum, gold, sulphur, rock salt, &c. &c.. have been discovered, in various localities, which will prove of great commercial advantage in view of the important trade between China and the islands of the Pacific and western coast."

In the prosecution of his surveys, Dr. Evans was assisted by Dr. B. F. Shumard, of St. Louis, who has kindly placed in my hands a large amount of information, concerning the discoveries made on his surveys, and also an account of Dr. Evans' discoveries in the *Mauvaises Terres*, of a vast number of bones representing the ancient and extinct fauna of Nebraska, a region explored by Dr. Evans, while in the employ of Dr. D. D. Owen, researches from which Dr. Leidy derived those interesting materials, for his very valuable memoir. The attention of scientific men was first called to the *Mauvaises Terres*, as a charnel house of fossil remains, by Dr. Hiram A. Prout, (see this Journal, [2], vol. ii, page 248).

To Dr. Evans is also due the discovery of the Pass of the Rocky Mountains, named after Cadotte, who is not its original discoverer, as we are assured by Dr. Shumard, as well as by Dr. Evans himself.

We omit the very interesting descriptions, which, both Dr. Evans and Dr. Shumard have given of their wilderness adventures, trials and perils; but before closing this paper, I would say that Dr. Evans, in his journey across the Rocky Mountains, met with the usual misfortunes which attended all early travellers in that desolate region:—that he was reduced to the necessity of killing and eating his pet dog after having, in his own words, "thrown away bread to preserve stones:"—that his mules gave way under labor and privations, amid these fastnesses, and were left to die, while our geologist, braving all dangers and fatigues, forced his way over the mountains and reached his destination in safety.

Dr. Evans, fortunately for himself, acquired a high renown among the Indians, for his supposed power of curing the cholera, and his Indian name means, the medicine man who kills the cholera, he having been fortunate in his treatment of the cases, which came under his care. On one occasion, a delegation of chiefs waited upon him, and besought him to "make medicine," (perform some mysterious rite), so that the Great Spirit would send them plenty of Buffaloes, protect their corn from frost, and give them a moderate winter." They fully believed in his great

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influence with the celestial powers, and to this superstition, undoubtedly, he owed his life in his adventurous travels, amid the war paths of hostile Indians. He was informed that all the chiefs of the tribes west of the Rocky Mountains knew him; for they have a way of telegraphing intelligence to great distances, without the aid of electricity. Dr. Evans's sextant, on one occasion, certainly saved his life from predatory Indians, who came to kill him and his party, but were awed by his bringing down the sun at his will, and they went away and reported that they dared not kill him; for some great misfortune would be sure to fall upon the tribe if they injured so great a medicine man. Large parties of miners have been killed when endeavoring to follow the paths which Dr. Evans passed in safety, and a party of a dozen of them were killed soon after Dr. Evans left Rogue River Mountains when they endeavored to visit the spots he had explored.

Dr. Evans went to Central America last year as geologist to the Chiriqui Exploring Expedition. He there discovered, in the lagoon districts of the Gulf of Chiriqui, an abundance of excellent bituminous coals of the Eocene Tertiary age, the aggregate thickness of the beds being 73½ feet, while their mean thickness was not far from four or five feet. Six of the beds, he states, are so contiguous one over the other as to be mined together in a thickness of clear coal of thirty feet.

Such a deposit, of good coals, was of vast importance to the enterprise then in contemplation, of opening a new route across the Isthmus to the Pacific Ocean—a project which we trust will be revived, when the unhappy war in which the country is now engaged shall be brought to an end.

These coals, analyzed by the writer, were found to be of excellent quality, and suitable for all the uses to which good bituminous coals are applied. These Tertiary coals undoubtedly contain succinic acid, for they give out the fragrant odor of burning amber when heated. They differ from the lignites of northern Tertiary beds entirely, and seem to point to a condition of things such as must have existed during the older and regular Coal formation.

The gorgeous scenery of the tropical forests, and luxuriance of vegetation in Central America, seem to have strongly impressed Dr. Evans, and he expressed in his letters to the General Land Office an intention of removing with his family to Chiriqui. A dangerous delusion! for the destructive effects of that seductive climate have proved fatal to nearly all the northern explorers who have labored there, and we have no doubt that Dr. Evans' constitution was enfeebled by his exposure in that region during the summer months and the rainy season, so as to render him incapable of resisting the very mild attack of pneumonia, which ended his career by death, in Washington, April 18th, 1861.

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He died in the midst of his labors, and before they had been made public; but his work had reached a state to ensure it from being lost to the world. A simple resolution of Congress is now all that is needed to bring forth from the government press his report containing, as we believe, matter of value in this country alike to science and the general public.

Boston, September 1, 1861.

ART. XXXVI.—*On the great Auroral Exhibition of Aug. 28th to Sept. 4th, 1859, and on Auroras generally.*—8TH ARTICLE; by ELIAS LOOMIS, Professor of Natural Philosophy and Astronomy in Yale College.

SINCE the publication of my seventh article on the great auroral exhibition of Aug. 28th to Sept. 4th, 1859, I have received from Prof. Hansteen a copy of the observations made at Christiania, Norway, corresponding to those made at Hobarton, as given in this Journal, vol. xxxii, p. 81. These observations are published in the Memoires de l'Academie de Belgique, tome xx, pp. 103–116, and Bulletins de l'Academie Royale de Belgique, tome xxi, pp. 284–298.

Observations of the Aurora at Christiania, Norway, lat. 59° 54′, long. 10° 43′ E. Magnetic dip in 1859, 71° 18′.

Day.			Hour.	Notices of Auroras.
1841.	March	15,	10^h	Aurora.
	March	22,		Rain.
	May	17,		Rain.
	July	20,		No aurora visible.
1842.	Feb.	18,	11–14	Aurora faint.
	April	11,	9–15	Slight aurora. Faint arch at 15^h.
	April	12,	9–14	Rays and flames extending to the zenith.
	April	13,	9–13	Rays and flames.
	April	15,	11–15	Flaming aurora.
	July	2,	10 and 12	The bifilar magnetometer was quite out of scale.
1844.	April	17,	9	Faint aurora, extending nearly to the zenith.
1846.	Sept.	22,	7–15	Vehement flames over three-fourths of the heavens. Reddish. Corona imperfect.
1847.	April	21,	11–14	Flaming and radiating aurora.
	Sept.	24,	7–10	Corona formed. Rays of a dark red color.
	Sept.	26,	10	Magnificent arc, radiating.
	Oct.	22,	10	Rain.
	Oct.	23,	6	High aurora, radiating behind clouds.
	Oct.	24,	5½–12	One of the most brilliant auroras we have observed. Corona formed. Vivid colors, red and yellow.
	Dec.	19,	10	Strong aurora, yellow rays, red masses without motion.
1848.	March	24.		Rain.
	April	5.	10	Faint aurora.
	April	7.	10	Arc radiating.
	Oct.	18,	7½–10	Vigorous radiation over the whole vault. Red color very intense.
	Nov.	19,	10	Aurora.
	Dec.	22.	10	Faint aurora.

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We thus see that in twenty-one cases out of thirty-four, an aurora was recorded at Christiania within twenty-four hours of an aurora at Hobarton; and considering the number of auroras which must be rendered invisible by clouds and by day-light, we may safely conclude that almost every auroral exhibition at Hobarton is accompanied by a nearly simultaneous exhibition in Norway.

In successive numbers of this Journal, commencing with November, 1859, we have given a full report of observations upon the great auroral exhibition of August and September, 1859. This display was probably unsurpassed by any similar phenomenon on record, not only for its magnificence, but also for its geographical extent; and fortunately we have a greater amount of information respecting it, than was ever collected respecting any former aurora. These observations afford the materials for settling many questions which have hitherto been regarded as open to debate.

The aurora of Aug. 28th was witnessed throughout Oregon and California, longitude 124° W.; in Utah and New Mexico, longitude 111° W.; from Kansas, long. 95° W., to Maine, long. 70° W.; at Halifax, long. 63° W.; on the Atlantic Ocean in long. 45° W., 27° W., and 10° W.; and in Europe from longitude 2° W. to 18° E. Also in Asia from long 60° E. to 119° E., the disturbance of the magnetic instruments was very remarkable, although being generally cloudy, no mention was made of the auroral light. It hence appears highly probable that this auroral display extended to every meridian of the northern hemisphere. The aurora of Sept. 2d was observed at the same stations as that of Aug. 28th, besides which we have learned that this aurora was witnessed at the Sandwich Islands in long. 157° W., and from Eastern to Western Asia the disturbance of the magnetic instruments was well nigh unprecedented for its violence, so that we cannot doubt that this display extended to every meridian of the northern hemisphere.

The auroral display in the southern hemisphere was cotemporaneous with that in the northern, and was perhaps equally remarkable. Both of these auroras were observed in South America and in Australia, in latitudes where such exhibitions are extremely rare.

The southern limit of these auroral displays was not the same upon all meridians. In North America, the aurora of Aug. 28th appeared in the zenith as far south as lat. 36° 40′; and it attracted general attention as far south as lat. 18°. In Central Europe, this aurora extended to the zenith of places as far south as about lat. 45°. It was brilliant at Rome in lat. 42°, but was not noticed at Athens in lat. 38°; neither was it seen in Western Asia in lat. 40°.

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In North America, the aurora of Sept. 2d appeared in the zenith at places as far south as lat. 22½°, and attracted general attention in lat. 12°; and if the sky had been clear, some traces of the aurora might probably have been detected even at the equator. In Europe this aurora was noticed at Athens, in lat. 38°. Both of these auroras conformed to the general law of auroral distribution, as developed in this Jour., vol. xxx, pp. 89–94, the region of greatest auroral action being in America about 15° further south than in eastern Europe.

We have been able to collect sufficient materials for determining with tolerable precision the height of these auroral displays above the earth's surface. At the most southern stations, the aurora rose only a few degrees above the northern horizon; at more northern stations, the aurora rose higher in the heavens; at certain stations it just attained the zenith; at stations further north the aurora covered the entire northern heavens, as well as a portion of the southern; and at places further north the entire visible heavens, from the northern to the southern horizon, were overspread with the auroral light. The following table presents a summary of a few of the most definite observations on the aurora of Aug. 28th, 1859, at about $8^h\ 42^m$ P. M., New Haven time.

Table I.

Locality.	Latitude.	Extent of auroral display.	Authority.
North side of Jamaica,	18° 20′	Like the light of a fire.	A. J., v 29, p. 265.
Inagua, Bahamas,	21 18	Remarkably brilliant.	" v. 29, p. 264.
Havanna, Cuba,	23 9	Rose 23° above the north horizon.	" v. 28, p. 404.
Key West, Florida,	24 33	Rose about 30° " "	" v. 30, p. 349.
Savannah, Georgia,	32 5	Rose some 45° " "	" v. 29, p. 262.

The following table presents a summary of observations of the same aurora, made at the same hour, at places where the auroral light covered the entire northern heavens as well as a portion of the southern.

Table II.

Locality.	Latitude.	Extent of auroral display.	Authority.
Sandy Spring, Md.,	39° 9′	Extended to 51° from south horizon.	A. J., v. 29, p. 259.
Gettysburgh, Pa.,	39 49	" 30 " "	" v. 30, p. 345.
Philadelphia, Pa.,	39 57	" 22½ " "	" v. 29, p. 259.
Burlington, N. J.,	40 5	" 20 " "	" v. 29, p. 258.
New Haven, Conn.,	41 18	" 10½ " "	" v. 28, p. 391.
West Point, N. Y.,	41 23	" 12 " "	" v. 28, p. 394.
Newburyport, Mass.,	42 48	" 6 " "	" v. 29, p. 254.
Lewiston, Maine,	44 5	" 5 " "	" v. 28, p. 386.

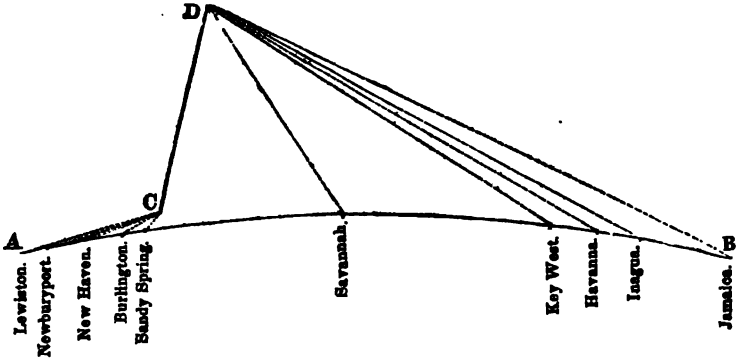
If we combine the preceding observations in Table II. we shall find that *the lower limit* of the auroral light was elevated forty-six miles above the earth's surface, and that its southern margin was vertical over the parallel of 38° 50′ N. latitude in Virginia.

Now it is considered as established that the auroral streamers are luminous beams sensibly parallel to the direction of the dipping needle. But the dip of the needle in lat. 38° 50′ in Vir-

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ginia is 71° 20′; and if we draw a line CD, figure 1, making an angle of 71° 20′ with the curve line AB which represents a portion of the earth's surface, we may assume that the line CD represents the southern boundary of the auroral illumination. If then we assume that the observations of Table I. were made upon the point D, we shall find that *the upper limit* of the auroral light was elevated 534 miles above the earth's surface, and that its southern margin was vertical over the parallel of 36° 40′ north latitude in Virginia.

Fig. 1.



The following table presents a summary of the most definite observations of the aurora of Sept. 2, 1859, made generally about 2 A. M. Havanna time.

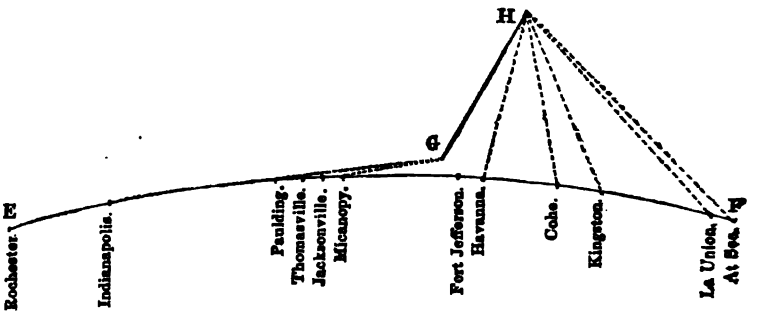
Table III.

Locality.	Latitude.	Longitude.	Hour.	Extent of auroral display.	Authority.
	° ′	° ′			
At Sea,	12 23	88 28	midnight	Sky lurid—wavy appearance.	A. J., v. 30, p. 361.
La Union, San Salvador,	13 18	87 45	10–3 A.M.	About 30° above the North horizon.	v. 29, p. 265.
Salvador,	13 44	88 55		Same as at La Union.	v. 29, p. 266.
Kingston, Jamaica,	17 58	76 50	1–5 A.M.	Appeared like a colossal fire.	v. 29, p. 265.
Cohe, Cuba,	20 0	76 10		Extended upwards about 72°.	v. 29, p. 265.
Havanna, Cuba,	23 9	82 22	2 A. M.	More than 100° in height.	v. 28, p. 405.
Fort Jefferson, Fla.	24 37	82 52	2 A. M.	Extended beyond the zenith.	v. 30, p. 360.
Micanopy, Fla.	29 30	82 18	2·30 A.M.	Corona very distinct.	v. 30, p. 360.
Jacksonville, Fla.	30 15	82 0	3 A. M.	Extreme south in a red glow.	v. 30, p. 359.
Thomasville, Ga.	30 50	84 0	2 A. M.	Corona formed.	v. 30, p. 358.
Paulding, Miss.	32 20	89 20	2·10 A.M.	Whole visible heavens overspread.	v. 30, p. 357.
Indianapolis, Ind.	39 55	86 5		Down to south horizon.	v. 28, p. 398.
Rochester, N. Y.	43 8	77 51	2 A. M.	Down to south horizon.	v. 29, p. 253.

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If we combine the last seven observations of the preceding Table, we shall find that *the lower limit* of the auroral light was elevated fifty miles above the earth's surface, and that its southern margin was vertical over the parallel of 25° 15′ north latitude in Florida. Now the dip of the magnetic needle in Florida in latitude 25° 15′ is 55° 40′; and if we draw GH, figure 2, making an angle of 55° 40′ with the curve line EF, which represents a portion of the earth's surface, and assume that the line GH represents the southern boundary of the auroral illumination, and that the first five observations of Table III. were made upon the point H, we shall find that *the upper limit* of the auroral light was elevated 495 miles above the earth's surface, and that its southern margin was vertical over the parallel of 22° 30′ N. latitude in Cuba.

Fig. 2.



We have thus discovered the geographical position of this auroral light. The aurora of Sept. 2d formed a belt of light encircling the northern hemisphere, extending southward in North America to lat. 22½°, and reaching to an unknown distance on the north; and it pervaded the entire interval between the elevations of 50 and 500 miles above the earth's surface. This illumination consisted chiefly of luminous beams or columns, everywhere parallel to the direction of a magnetic needle when freely suspended; that is, in the United States, these beams were nearly vertical, their upper extremities being inclined southward at angles varying from 15° to 30°. These beams were therefore about 500 miles in length; and their diameters varied from five to ten and twenty miles, and perhaps sometimes they were still greater.

These beams were simply illumined spaces, and the illumination was produced by a flow of electricity. That this illumination was produced by electricity is proved by the observations of the magnetic telegraph. During these auroral displays, there were developed on the telegraph wires electric currents of sufficient power to serve as a substitute for the ordinary voltaic bat-

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tery. That the agent thus excited upon the telegraph wires was indeed electricity, is abundantly proved. Electricity produces various effects by which it may be distinguished from all other agents.

1. In passing from one conductor to another, electricity exhibits a spark of light. During the auroras of Aug. 28th and Sept. 2d, brilliant sparks were drawn from the telegraph wires, even when no battery was attached. At Springfield, Mass., a flash was seen about half the size of an ordinary jet of gas. (This Jour., xxix, 95). At Washington, D. C., a spark of fire jumped from the forehead of a telegraph operator when his forehead touched a ground wire. (This Jour., xxix, 97.) At Pittsburgh, Pa., streams of fire were seen when the telegraph circuit was broken. (Ib., xxix, 97.) At Boston, Mass., a flame of fire followed the pen of Bain's chemical telegraph. (Ib., xxix, 93.) On the telegraph lines of Norway, sparks and uninterrupted discharges were observed. (Ib., xxix, 388.) Bright sparks were noticed on the conductors of the telegraph lines to Bordeaux in France. (Ib., xxix, 392.)

2. In passing through poor conductors, electricity develops heat. During the auroras of Aug. 28th and Sept. 2d, paper and even wood were set on fire by the auroral influence alone. At Pittsburgh, Pa., the magnetic helices became so hot that the hand could not be kept on them. (Ib., xxix, 97.) At Springfield, Mass., the heat was sufficient to cause the smell of scorched wood and paint to be plainly perceptible. (Ib., xxix, 96.) At Boston, Mass., a flame of fire burned through a dozen thicknesses of paper. The paper was set on fire and produced considerable smoke. (Ib., xxix, 93.) On the telegraph lines of Norway, pieces of paper were set on fire by the sparks of the discharges from the wires; and the current was at times so strong that it was necessary to connect the lines with the earth in order to save the apparatus from destruction. (Ib., xxix, 388.)

3. When passed through the animal system, electricity communicates a shock which is quite peculiar and characteristic. During the auroras of Aug. 28th and Sept. 2d, some of the telegraph operators received severe shocks when they touched the telegraph wires. At Philadelphia, the current gave a severe shock. (Ib., xxix, 96.) At Washington, D. C., the telegraph operator received a severe shock which stunned him for an instant. (Ib., xxix, 97.)

4. A current of electricity develops magnetism in ferruginous bodies. The aurora of Sept. 2d developed magnetism so abundantly and so steadily that on several lines it was used as a substitute for a voltaic battery in the ordinary business of telegraphing. (Ib., xxix, 94, 96 and 97.) The intensity of this effect was estimated to have been at times equal to that of 200 cups of

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Grove's battery. (Ib., xxix, 93.) In Switzerland, the currents were at least three fold the ordinary current employed in telegraphing. (Ib., xxix, 396.)

5. A current of electricity deflects a magnetic needle from its normal position. In England, the usual telegraph signal is made by a magnetic needle surrounded by a coil of copper wire, so that the needle is deflected by an electric current flowing through the wire. Similar deflections were caused by the auroras of Aug. 29th and Sept. 2d, and these deflections were frequently greater than those produced by the telegraph batteries. (Ib., xxxii, 74.)

6. A current of electricity produces chemical decompositions. During the display of Sept. 2d, the auroral influence produced the same marks upon chemical paper as are produced by an ordinary voltaic battery; that is, the auroral influence decomposed a chemical compound, the cyanid of potassium. (Ib., xxix, 95.) The same effect was produced by the aurora of Feb. 19, 1852. (Ib., xxix, 93.)

It is thus abundantly proved that the fluid developed by the Aurora on the telegraph wires was indeed electricity. This electricity may be supposed to have been derived from the Aurora either by transfer or by induction. If we adopt the former supposition, then the auroral light is certainly electric light. If we adopt the latter supposition, then we must enquire what known agent is capable of inducing electricity in a distant conductor. We know of but two such agents, Magnetism and Electricity. But the auroral fluid was luminous, while magnetism is not luminous. We seem then compelled to admit that the auroral light is electric light.

Admitting then that the Aurora is but an effect of electric currents, it is important to determine in what direction these currents flow, and what laws they observe. Do these currents move in a vertical, or horizontal direction, or in some intermediate direction? Is there any uniformity in the direction of these currents? Our most important means of information upon this subject are derived from the observations upon telegraph lines.

The observations published in this Journal, vol. xxix, pp. 92–97, show that on a large number of telegraph lines in the United States, the electric currents moved alternately to and fro. Such was the case upon the line from Boston to Portland running N. 24° E.; from Boston to Manchester running N. 25° W.; from Boston to Cambridge almost due West; from Boston to Springfield S. 79° W; from South Braintree to Fall River running S. 12° W; from Boston to New Bedford running S. 7° E.; from Springfield to Albany running N. 58° W.; from New York to Philadelphia running S. 49° W.; from Philadelphia to Pittsburgh running N. 82° W.; and from Washington to Richmond running S. 15° W.

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Now whatever may be the direction of the current on the surface of the earth, it is evident that if this current travels on a telegraph wire, it must appear to move in the direction of the wire; and a current moving across the earth's surface in any fixed direction might be forced to travel over telegraph lines making various angles with this direction; but its efficiency would vary according to the inclination of the conducting wire to the direction of the current. The following table shows the effect of a current assumed to move from N. 45° E., to S. 45° W. Column first contains a list of the telegraph lines; column second shows their directions; column third shows the angle which the assumed current makes with each telegraphic line; and column fourth shows the fraction of the entire current which would be efficient upon such a line.

Telegraph lines.	Direction.	Inclination of current.	Efficient current.
Boston to Cambridge,	West.	45°	0·71
Philadelphia to Pittsburgh,	N. 82° W.	53	·60
Springfield to Albany,	N. 58 W.	77	·22
Boston to Manchester,	N. 25 W.	70	·34
New Bedford to Boston,	N. 7 W.	52	·62
Fall River to Braintree,	N. 12 E.	33	·84
Richmond to Washington,	N. 15 E.	30	·87
Boston to Portland,	N. 24 E.	21	·93
Philadelphia to New York,	N. 49 E.	4	·99
Springfield to Boston,	N. 79 E.	34	·83

We thus see that on one-half of these telegraph lines a current assumed to proceed from N. 45° E. would exert nearly its entire force; and on only two of them would so small a part as one half of its entire force be exerted. From Boston to Manchester, only one third of the entire current would be efficient, and this would perhaps be sufficient to explain the effects mentioned in vol. xxx, p. 95. From Springfield to Albany only one fourth of the entire current would be efficient. If this should be thought inadequate to explain the facts mentioned in vol. xxx, p. 95, it may be necessary for us to admit, that the direction of the electric current was subject to occasional fluctuations. If the force of the electric current upon each of the telegraph lines had been actually measured by a galvanometer, we should probably be able to determine whether the direction of the current was invariable, and what was its prevalent direction. At present we can only infer that all the facts reported are consistent with the supposition of electric currents moving to and fro on the earth's surface, whose average direction was from about N. 45° E. to S. 45° W.

The observations published in this Journal, vol. xxxii, pp. 74–96, give us more definite information respecting the strength of the currents as well as their direction. Between Ashford and Margate there were recorded 36 north currents and 31 south

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currents; from Ashford to Ramsgate 24 north currents and 19 south currents; and from Margate to Ramsgate nine north currents and five south currents; that is, currents from north to south were somewhat more frequent than currents from south to north. Between Ashford and Margate the northerly currents were on an average one degree stronger than the southerly; between Ashford and Ramsgate the southerly currents were on an average four degrees stronger than the northerly; while between Margate and Ramsgate the northerly currents were on an average six degrees stronger than the southerly. Mr. Charles V. Walker from a discussion of these and other similar observations has arrived at the conclusion that in the S.E. part of England, *there is a stream of electricity of indefinite width drifting across the country, moving to and fro along a line directed from N. 42° E. to S. 42° W.*

Now it is well known that an electric current has the power of deflecting a neighboring magnetic needle; the needle always tending to take up a position at right angles to the direction of the current; and if the direction of the current be reversed, the north pole of the magnetic needle will be deflected in a direction contrary to what it was in the first case. Mr. C. V. Walker has compared the magnetic observations made at Greenwich and Kew, and has discovered that the deflections of the magnets there observed were such as should be produced by the electric currents observed on the telegraph wires, (Proc. Roy. Soc., Feb. 14, 1861). We may then employ observations of the magnetic needle as indicating the direction and force of the electric currents near the earth's surface.

In the year 1835, there was formed in Germany a Magnetic Union, which included Philosophers from every part of Germany, and which in a few years spread over nearly every part of Europe. The object of this Association was to make simultaneous observations of the magnetic needle. The observations were all made in Göttingen mean time, at intervals of five minutes for a period of 24 hours on certain days of the year previously agreed upon. These observations were annually published in a volume entitled 'Resultate aus den Beobachtungen des magnetischen Vereins,' and afford the best materials we have for comparing the effect of electric currents over large portions of the earth's surface. These observations have been projected in curves which exhibit to the eye at a glance the movements of the magnetic needle at each station. On comparing these curves, we find a remarkable similarity at places widely separated from each other. From Göttingen to Munich (distant in a straight line more than 250 miles) the curves are ordinarily almost parallel to each other; and the changes take place sensibly at the same instant of absolute time, with this modification, that the extent of the deflections is generally somewhat greater at the

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more northerly stations. I have made a careful comparison of these observations for the purpose of determining whether these movements of the magnetic needles were strictly simultaneous. The following catalogue exhibits a list of those cases which afford the most satisfactory data for comparison, viz., when there was a well marked maximum or minimum value of the magnetic declination, and when this maximum or minimum value was of short duration. In the following list, all the dates are expressed in the mean time of Göttingen.

Observed deflections of the horizontal magnetic needle.

	d	h	m	
1. 1836.	Aug. 17.	7	50,	Maximum at Upsala, Berlin, Göttingen, Leipsic and Munich.
		7	55,	Maximum at Hague.
2. 1836.	Aug. 17.	9	50,	Max. at Upsala, Berlin, Hague, Göttingen, Leipsic and Munich.
3. 1836.	Aug. 17.	10	10,	Minimum at Upsala, Leipsic and Munich.
		10	15,	Min. at Berlin, Hague and Göttingen.
4. 1836.	Aug. 17.	10	30,	Max. at Berlin, Leipsic and Munich.
		10	35,	Max. at Upsala, Hague and Göttingen.
5. 1836.	Sep. 24.	8	55,	Max. at Upsala, Berlin, Hague, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
6. 1836.	Sep. 24.	11	0,	Min. at Hague.
		11	5,	Min. at Upsala, Berlin, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
7. 1836.	Sep. 24.	18	40,	Max. at Upsala, Berlin, Hague, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
8. 1836.	Sep. 24.	18	50,	Min. at Upsala, Berlin, Hague, Göttingen, Breslau, Leipsic, Marburg and Munich.
		18	55,	Min. at Milan.
9. 1836.	Sep. 24.	19	0,	Max. at Upsala, Berlin, Hague, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
10. 1836.	Sep. 24.	21	10,	Max. at Upsala.
		21	15,	Max. at Berlin, Hague, Göttingen, Breslau, Leipsic, Marburg and Munich.
		21	20,	Max. at Milan.
11. 1837.	Jan. 28.	8	55,	Max. at Upsala, Altona, Berlin, Göttingen, Breslau, Freiberg, Augsburg, Munich and Milan.
12. 1837.	Jan. 28.	9	30,	Min. at Upsala, Altona, Berlin, Göttingen, Breslau, Leipsic, Freiberg, Marburg, Augsburg, Munich and Milan.
13. 1837.	Jan. 28.	12	30,	Max. at Upsala, Altona, Berlin, Breda, Göttingen, Leipsic, Breslau, Freiberg, Marburg, Augsburg. Munich and Milan.
14. 1837.	Jan. 28.	21	30,	Max. at Upsala, Altona, Berlin, Breda, Göttingen, Leipsic, Breslau, Freiberg, Marburg, Augsburg, Munich and Milan.
15. 1837.	May 28.	9	45,	Max. at Copenhagen.
		9	50,	Max. at Upsala, Berlin, Breda, Göttingen, Breslau and Marburg.
		9	55,	Max. at Munich and Milan.
		10	0,	Max. at Leipsic.
16. 1837.	July 29.	6	20,	Max. at Petersburgh.
		6	35,	Max. at Upsala and Copenhagen.
		6	40,	Max. at Berlin, Breda, Göttingen, Breslau, Leipsic, Freiberg, Marburg, Munich and Milan.
17. 1837.	July 29.	7	0,	Min. at Petersburgh.
		7	15,	Min. at Upsala, Copenhagen and Breslau.

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		d	h	m	
	1837.	July 29.	7	20,	Min. at Berlin, Breda, Göttingen, Freiberg, Leipsic, Marburg and Munich.
18.	1837.	July 29.	8	55,	Max. at Petersburgh.
			9	0,	Max. at Upsala, Copenhagen, Berlin and Breslau.
			9	5,	Max. at Göttingen, Leipsic, Freiberg, Marburg, Munich and Milan.
19.	1837.	July 29.	11	40,	Max. at Upsala, Berlin, Breda, Göttingen, Breslau, Leipsic, Freiberg, Marburg, Munich and Milan.
20.	1837.	July 29.	12	10,	Min. at Petersburgh, Copenhagen, Berlin, Breda, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
21.	1837.	July 29.	14	25,	Min. at Breda.
			14	25 to 30,	Min. at Göttingen.
			14	30,	Min. at Petersburgh, Berlin, Breslau, Leipsic, Marburg, Munich and Milan.
22.	1837.	Aug. 31.	6	35,	Max. at Upsala, Berlin, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
			6	45,	Max. at Dublin.
23.	1837.	Aug. 31.	8	55,	Min. at Upsala.
			9	0,	Min. at Berlin, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
			9	5,	Min. at Dublin.
24.	1837.	Aug. 31.	9	20,	Max. at Upsala.
			9	25,	Max. at Berlin, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
			9	30,	Max. at Dublin.
25.	1837.	Aug. 31.	9	50,	Min. at Upsala, Berlin, Göttingen, Breslau, Leipsic, Marburg and Munich.
			9	55,	Min. at Dublin and Milan.
26.	1837.	Aug. 31.	10	25,	Max. at Upsala, Berlin, Göttingen, Breslau and Leipsic.
			10	30,	Max. at Dublin, Marburg, Munich and Milan.
27.	1837.	Aug. 31.	17	45,	Max. at Upsala, Berlin, Göttingen, Breslau, Leipsic, Marburg, Munich and Milan.
			17	50,	Max. at Dublin.
28.	1837.	Aug. 31.	19	5,	Max. at Upsala.
			19	10,	Max. at Berlin, Göttingen, Breslau, Leipsic, Marburg and Munich.
			19	15,	Max. at Dublin and Milan.
29.	1837.	Sep. 30.	3	50,	Max. at Upsala, Copenhagen, Berlin, Göttingen, Breslau, Leipsic, Marburg and Milan.
30.	1837.	Sep. 30.	7	30,	Max. at Upsala, Copenhagen, Berlin, Göttingen, Breslau, Leipsic, Marburg and Milan.
			7	35,	Max. at Breda.
31.	1837.	Sep. 30.	10	45,	Min. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Breslau, Marburg and Milan.
32.	1837.	Sep. 30.	12	35,	Min. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Breslau, Leipsic, Marburg and Milan.
33.	1837.	Sep. 30.	14	10,	Max. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Leipsic, Marburg and Milan.
34.	1837.	Nov. 13.	6	25,	Max. at Petersburgh, Upsala, Stockholm, Copenhagen, Berlin, Göttingen, Breslau, Leipsic, Freiberg and Marburg.
			6	35,	Max. at Munich.
			6	40,	Max. at Dublin.
35.	1837.	Nov. 13.	8	50,	Min. at Petersburgh, Upsala and Stockholm.
			9	5,	Min. at Copenhagen, Berlin, Breda, Göttingen, Breslau, Freiberg, Leipsic and Marburg.
			9	10,	Min. at Milan.
			9	15,	Min. at Dublin and Munich.
36.	1837.	Nov. 13.	9	20,	Max. at Petersburgh, Upsala and Stockholm.
			9	25,	Max. at Copenhagen, Berlin, Breda, Göttingen, Breslau, Freiberg, Leipsic and Marburg.
			9	30,	Max. at Dublin.
			9	35,	Max. at Munich.

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		d	h	m	
37.	1837.	Nov.	13.	10	25, Max. at Upsala, Stockholm, Copenhagen, Berlin, Breda, Göttingen, Leipsic, Breslau, Freiberg, Marburg and Milan.
				10	30, Max. at Dublin.
				10	35, Max. at Munich.
				10	35 to 40, Max. at Petersburgh.
38.	1837.	Nov.	13.	11	25, Min. at Breda.
				11	25–30, Min. at Dublin.
				11	35, Min. at Berlin, Göttingen, Freiberg, Leipsic and Milan.
				11	40, Min. at Upsala.
				11	45, Min. at Petersburgh, Stockholm, Copenhagen and Munich.
39.	1838.	Jan.	27.	7	35, Max. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Breslau, Leipsic and Milan.
				7	40, Max. at Marburg and Munich.
40.	1838.	Mar.	31.	23	20, Min. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Breslau, Marburg, Munich and Milan.
41.	1838.	Nov.	24.	7	35, Min. at Upsala, Berlin, Göttingen, Breslau, Leipsic and Milan.
				7	40, Min. at Breda and Munich.
42.	1838.	Nov.	24.	8	5, Max. at Upsala and Breslau.
				8	10, Max. at Seeburg, Breda, Göttingen, Leipsic, Marburg, Munich and Milan.
43.	1839.	Feb.	22.	13	45 to 50, Min. at Breda.
				13	50, Min. at Greenwich and Munich.
				13	55, Min. at Berlin, Göttingen, Marburg and Milan.
				14	0, Min. at Breslau, Leipsic and Heidelberg.
				14	5, Min. at Upsala.
44.	1839.	Aug.	30.	10	20, Min. at Upsala, Copenhagen, Berlin, Breda, Göttingen, Breslau, Leipsic, Marburg, Prague, Kremsmunster, Munich and Milan.
45.	1839.	Aug.	30.	10	35, Max. at Upsala.
				10	35 to 40, Max. at Breda.
				10	40, Max. at Copenhagen, Berlin, Breslau, Leipsic, Prague, Kremsmunster and Munich.
				10	45, Max. at Göttingen, Marburg and Milan.
46.	1839.	Aug.	30.	10	55, Min. at Upsala.
				11	0, Min. at Copenhagen, Berlin, Breda and Breslau.
				11	5, Min. at Göttingen, Leipsic, Marburg, Prague, Kremsmunster, Munich and Milan.
47.	1839.	Aug.	30.	11	20, Max. at Upsala.
				11	20 to 25, Max. at Breda.
				11	25, Max. at Copenhagen, Berlin, Göttingen, Breslau, Leipsic, Marburg, Prague, Kremsmunster, Munich and Milan.
48.	1839.	Aug.	30.	16	45, Min. at Breda.
				16	50, Min. at Upsala, Copenhagen, Berlin, Prague and Munich.
				16	50 to 55, Min. at Göttingen.
				16	55, Min. at Leipsic, Breslau and Marburg.
49.	1839.	Aug.	30.	17	5 to 10, Max. at Breda.
				17	15, Max. at Upsala, Berlin, Göttingen, Breslau, Leipsic, Prague, Marburg, Munich and Milan.
50.	1839.	Aug.	30.	18	30, Min. at Breda.
				18	35, Min. at Munich.
				18	40, Min. at Upsala, Copenhagen, Berlin, Göttingen, Breslau, Leipsic, Prague, Kremsmunster and Milan.
				18	45, Min. at Marburg.
51.	1839.	Aug.	30.	20	0, Max. at Breda.
				20	5, Max. at Munich.
				20	10, Max. at Upsala, Copenhagen, Berlin, Göttingen, Leipsic, Breslau, Marburg, Prague, Kremsmunster and Milan.
52.	1839.	Aug.	31.	8	20, Max. at Breda.
				8	25, Max. at Upsala.

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		d	h	m	
	1839.	Aug.	31.	8 30,	Max. at Copenhagen, Berlin, Göttingen, Leipsic, Breslau, Marburg, Prague, Kremsmunster, Munich and Milan.
53.	1839.	Nov.	30.	6 25,	Min. at Upsala.
				6 30,	Min. at Copenhagen, Seeburg, Berlin, Göttingen, Breslau, Leipsic, Marburg, Prague, Kremsmunster and Milan.
				6 35,	Min. at Dublin.
				6 40,	Min. at Breda.
54.	1840.	May	29.	10 20,	Min. at Upsala.
				10 25,	Min. at Copenhagen, Berlin, Breda, Göttingen, Leipsic, Breslau, Brussels, Cracow, Kremsmunster, Marburg and Milan.
				10 30,	Min. at Petersburgh and Prague.
55.	1840.	May	29.	11 10,	Min. at Petersburgh.
				11 20,	Min. at Upsala.
				11 25,	Min. at Copenhagen, Berlin, Breda, Göttingen, Leipsic, Breslau, Marburg, Cracow, Kremsmunster and Milan.
				11 30,	Min. at Greenwich, Brussels and Prague.
56.	1840.	May	29.	11 30,	Max. at Petersburgh.
				11 40,	Max. at Copenhagen, Breslau and Cracow.
				11 40 to 45,	Max. at Breda.
				11 45,	Max. at Göttingen, Leipsic, Brussels, Kremsmunster, Marburg and Milan.
				11 50,	Max. at Greenwich.
57.	1840.	May	29.	13 30,	Max. at Petersburgh.
				13 30 to 35,	Max. at Breda.
				13 35,	Max. at Upsala, Copenhagen, Göttingen, Breslau and Cracow.
				13 35 to 40,	Max. at Leipsic.
				13 40,	Max. at Berlin, Greenwich, Brussels, Prague, Kremsmunster and Milan.
58.	1840.	May	29.	16 10 to 15,	Max. at Breda.
				16 15,	Max. at Upsala, Copenhagen, Berlin, Göttingen, Leipsic, Breslau, Brussels, Cracow, Kremsmunster, Marburg and Milan.
				16 20,	Max. at Petersburgh.
59.	1840.	May	29.	16 45,	Min. at Petersburgh, Copenhagen and Breda.
				16 45-50,	Min. at Brussels.
				16 50,	Min. at Berlin, Greenwich, Göttingen, Leipsic, Breslau, Cracow and Kremsmunster.
				16 55,	Min. at Prague.
60.	1840.	Aug.	28.	10 30,	Min. at Petersburgh, Upsala, Copenhagen, Berlin, Göttingen, Breslau, Kremsmunster and Milan.
				10 30 to 35,	Min. at Leipsic and Prague.
				10 40,	Min. at Dublin, Breda and Brussels.
				10 45,	Min. at Greenwich.
61.	1840.	Aug.	28.	14 25,	Min. at Petersburgh and Upsala.
				14 40,	Min. at Copenhagen.
				14 45,	Min. at Greenwich, Göttingen, Leipsic, Brussels, Marburg, Breslau, Prague, Cracow and Milan.
				14 50,	Min. at Breda.
				15 0,	Min. at Dublin.
62.	1840.	Aug.	28.	17 10,	Max. at Dublin.
				17 20,	Max. at Greenwich, Brussels, Marburg and Kremsmunster.
				17 20-30,	Max. at Göttingen and Prague.
				17 25,	Max. at Breda.
				17 30,	Max. at Petersburgh, Copenhagen, Berlin, Leipsic, Breslau, Cracow and Milan.
				17 30-35,	Max. at Upsala.
63.	1840.	Aug.	28.	18 55,	Min. at Petersburgh, Upsala, Berlin, Göttingen, Breslau, Cracow, Marburg and Kremsmunster.
				19 0,	Min. at Dublin, Greenwich, Copenhagen, Breda, Leipsic, Brussels, Prague and Milan.

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		d	h	m	
64.	1840.	Nov.	28.	0 50,	Min. at Upsala, Stockholm, Copenhagen, Dublin, Greenwich, Berlin, Breda, Brussels, Göttingen, Leipsic, Breslau, Prague, Marburg, Kremsmunster, Cracow and Milan.
				0 55,	Min. at Petersburgh.
65.	1840.	Nov.	28.	2 55,	Min. at Petersburgh.
				3 10,	Min. at Upsala, Stockholm, Copenhagen and Breslau.
				3 15,	Min. at Dublin, Greenwich, Berlin, Breda, Brussels, Göttingen, Leipsic, Marburg, Kremsmunster and Milan.
66.	1840.	Nov.	28.	6 40,	Max. at Petersburgh, Stockholm and Copenhagen.
				6 45,	Max. at Berlin, Breda, Göttingen, Leipsic, Breslau, Prague, Cracow, Kremsmunster, and Milan.
				6 50,	Max. at Dublin, Greenwich and Marburg.
67.	1840.	Nov.	28.	9 45,	Min. at Petersburg, Upsala, Stockholm, Copenhagen, Dublin, Berlin, Greenwich, Breda, Brussels, Göttingen, Leipsic, Breslau, Prague, Marburg, Kremsmunster, Cracow and Milan.
68.	1841.	Feb.	26.	12 45,	Min. at Petersburgh.
				12 50,	Min. at Upsala, Stockholm and Copenhagen.
				12 50 to 13 0,	Min. at Göttingen.
				13 0,	Min. at Breda, Leipsic, Berlin, Marburg, Prague, Kremsmunster and Milan.
				13 5,	Min. at Breslau, Brussels and Geneva.
69.	1841.	Feb.	26.	13 25,	Max. at Upsala and Stockholm.
				13 30,	Max. at Copenhagen.
				13 35,	Max. at Berlin, Breda, Göttingen, Leipsic, Marburg, Prague and Cracow.
				13 40,	Max. at Breslau, Brussels and Geneva.
				13 45,	Max. at Milan.
70.	1841.	Feb.	26.	15 35 to 40,	Min. at Breda.
				15 40 to 45,	Min. at Göttingen, Geneva and Milan.
				15 45,	Min. at Petersburgh, Upsala, Stockholm, Copenhagen, Brussels, Berlin, Leipsic, Breslau, Marburgh, Prague, Kremsmunster and Cracow.
71.	1841.	Feb.	27.	5 15,	Max. at Petersburgh.
				5 25,	Max. at Upsala.
				5 30,	Max. at Copenhagen, Berlin, Göttingen, Leipsic, Breslau and Prague.
				5 35,	Max. at Breda, Brussels, Geneva and Milan.
72.	1841.	May	28.	14 5 to 10,	Max. at Breda and Kremsmunster.
				14 10,	Max. at Upsala, Stockholm, Christiania, Copenhagen, Dublin, Göttingen, Leipsic, Breslau, Brussels, Prague, Marburg, Cracow and Milan.
73.	1841.	Aug.	27.	10 45,	Max. at Petersburgh.
				10 55,	Max. at Stockholm.
				11 0,	Max. at Upsala and Christiania.
				11 5,	Max. at Copenhagen, Breda, Berlin, Göttingen, Leipsic, Breslau, Prague, Cracow, Kremsmunster, Geneva and Milan.
74.	1841.	Aug.	27.	12 40,	Min. at Christiania.
				12 45,	Min. at Upsala, Stockholm, and Copenhagen.
				12 50,	Min. at Petersburgh, Berlin, Göttingen, Leipsic, Breslau and Cracow.
				12 55,	Min. at Makerstoun, Breda, Prague and Kremsmunster.
75.	1841.	Aug.	27.	13 10,	Max. at Petersburgh, Upsala, Stockholm, Christiania, Copenhagen, Makerstoun, Berlin, Breda, Göttingen, Leipsic, Breslau, Prague, Cracow, Geneva and Milan.
76.	1841.	Nov.	27.	8 40,	Max. at Petersburgh and Stockholm.
				8 45,	Max. at Upsala, Christiania, Berlin, Breda, Göttingen, Leipsic, Breslau, Prague and Cracow.
				8 50,	Max. at Makerstoun and Brussels.

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The following table shows the latitude and longitude of the places mentioned in the preceding catalogue.

Station.	Latitude.	Longitude from Greenwich.	Station	Latitude.	Longitude from Greenwich.
Petersburgh,	59° 56′	30° 18′ E.	Leipsic,	51° 20′	12° 22′ E.
Christiania,	59 54	10 44	Breslau,	51 6	17 2
Upsala,	59 51	17 38	Freiberg,	50 55	13 20
Stockholm,	59 20	18 4	Brussels,	50 51	4 22
Copenhagen,	55 40	12 35 E.	Marburg,	50 48	8 41
Makerstoun,	55 36	2 31 W.	Prague,	50 5	14 25
Seeburg,	53 56	20 45 E.	Cracow,	50 3	19 58
Altona,	53 32	9 56 E.	Heidelberg,	49. 28	8 42
Dublin,	53 23	6 20 W.	Augsburg,	48 21	10 53
Berlin,	52 30	13 24 E.	Munich,	48 8	11 37
Hague,	52 4	4 19	Kremsmünster,	48 3	14 8
Breda,	51 35	4 47	Geneva,	46 11	6 9
Göttingen,	51 31	9 57	Milan,	45 28	9 12 E.
Greenwich,	51 28	0 0			

The following table shows for each station in how many cases the maximum deviation of the magnetic needle occurred earlier than at Göttingen; in how many cases it occurred at the same instant as at Göttingen; and in how many cases it occurred later than at Göttingen.

Maximum deviation of the magnetic needle.

	Earlier.	Simultaneous.	Later.		Earlier.	Simultaneous.	Later.
Petersburgh,	9	8	2	Munich,	8	20	6
Christiania,	1	8	0	Kremsmunster,	1	9	1
Upsala,	13	27	1	Hague,	0	6	1
Stockholm,	5	4	0	Breda,	4	21	2
Copenhagen,	7	17	0	Brussels,	0	4	4
Seeburg,	0	1	0	Marburg,	0	31	3
Altona,	0	3	0	Augsburg,	0	3	0
Berlin,	3	36	1	Geneva,	0	2	2
Leipsic,	2	39	1	Milan,	0	30	7
Breslau,	4	34	1	Makerstoun,	0	1	1
Freiberg,	0	9	0	Dublin,	1	1	9
Cracow,	1	9	0	Greenwich,	0	1	3
Prague,	1	12	1				

From this table we perceive that at most of the stations, the maximum deviation generally occurred simultaneously; that is, within a period of five minutes, for this is the interval of time between the observations. But at some of the stations the maximum generally occurred earlier than at Göttingen, while at others it generally occurred later than at Göttingen. If we draw through Göttingen a great circle of the earth running from N. 60° W. to S. 60° E., it will divide the stations in such a manner, that at all those on the N.E. side of this line, the maximum occurs earlier more frequently than later; while at all those on the S.W. side of it, the maximum occurs later more frequently than earlier. We may then conclude that the maximum deviation of the magnetic needle advances progressively like a wave over the earth's surface; and that the direction of its motion is nearly from N.E. to S.W.

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The following table shows for each station in how many cases the minimum deviation of the magnetic needle occurred earlier than at Göttingen; in how many cases it occurred at the same instant as at Göttingen; and in how many cases it occurred later than at Göttingen.

Minimum deviation of the magnetic needle.

	Earlier.	Simultaneous.	Later.		Earlier.	Simultaneous.	Later.
Petersburgh,	7	7	8	Heidelberg,	0	0	1
Christiania,	1	0	0	Munich,	3	12	3
Upsala,	11	17	2	Kremsmunster,	0	14	1
Stockholm,	3	4	1	Hague,	1	2	0
Copenhagen,	6	16	2	Breda,	5	15	6
Seeburg,	0	1	0	Brussels,	0	7	4
Altona,	0	1	0	Marburg,	0	26	1
Berlin,	1	31	0	Augsburg,	0	1	0
Leipsic,	1	28	2	Geneva,	0	1	1
Breslau,	3	26	2	Milan,	0	24	4
Freiberg,	0	4	0	Makerstoun,	0	0	1
Cracow,	0	9	0	Dublin,	1	3	7
Prague,	0	11	5	Greenwich,	1	5	3

We perceive from these observations that the progress of the magnetic minima was nearly in the same direction as that of the magnetic maxima. We may draw a great circle through Göttingen in such a manner that at every station on the N.E. side of this line, the minimum occurs earlier more frequently than later; while at all those on the S.W. side of this line (without any important exception), the minimum occurs later more frequently than earlier. This line runs from N. 62° W. to S. 62° E., indicating progress in a direction from N. 28° E. to S. 28° W.

We thus see that the average progress of the maxima and minima was very nearly in the same direction; and if the average direction for either of these classes of waves is constant, it is probably the same for both of them. We may therefore combine both maxima and minima in the same table, and we shall obtain the following result.

Extreme deviations of the magnetic needle.

	Earlier.	Simultaneous.	Later.		Earlier.	Simultaneous.	Later.
Petersburgh,	16	10	5	Heidelberg,	0	0	1
Christiania,	2	3	0	Munich,	6	32	9
Upsala,	24	44	3	Kremsmunster,	1	23	2
Stockholm,	8	8	1	Hague,	1	8	1
Copenhagen,	13	33	2	Breda,	9	36	8
Seeburg,	0	2	0	Brussels,	0	11	3
Altona,	0	4	0	Marburg,	0	57	4
Berlin,	4	67	1	Augsburg,	0	4	0
Leipsic,	3	67	3	Geneva,	0	3	3
Breslau,	7	60	3	Milan,	0	54	11
Freiberg,	0	13	0	Makerstoun,	0	1	2
Cracow,	1	18	0	Dublin,	2	4	16
Prague,	1	23	6	Greenwich,	1	6	6

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It is not improbable that the line which divides the stations at which the extreme deviations of the magnetic needle generally occurred earlier than at Göttingen, from those stations at which the extremes generally occurred later than at Göttingen, differs considerably from a great circle of the earth; but if we regard it as an arc of a great circle, then its direction must be from about N. 62° W. to S. 62° E., indicating a progress of the electric wave from N. 28° E. to S. 28° W.

It was stated on page 326 that Mr. C. V. Walker, from a discussion of the observations on the lines of telegraph in England, has arrived at the conclusion that in the S.E. part of England there is a stream of electricity drifting across the country from N. 42° E. to S. 42° W. We have now found that the irregular deflections of the magnetic needle, which are so remarkable during auroral displays, do not occur everywhere simultaneously, but are generally propagated over the surface of Europe in a direction from N. 28° E. to S. 28° W. It is possible that a more extended series of observations would show that these two directions are identically the same; but it is not improbable that the direction in England is somewhat different from that in Central Europe.

The time of greatest and least deflection at Dublin is on an average five minutes later than at Göttingen. Now Dublin is situated 222 miles from the great circle above mentioned, passing through Göttingen, indicating a progress of the electric wave of about 2700 miles per hour. The time of the extreme deviations at Upsala is on an average three and one-third minutes earlier than at Göttingen; while Upsala is situated 644 miles from the great circle above mentioned, indicating a progress of the electric wave equal to 11,000 miles per hour. If we make a like comparison for each of the other stations, we shall obtain velocities very unequal in amount. We thus perceive the difficulty of determining the average rate of progress of the electric wave. Sometimes the observations may be explained by supposing a single broad current of electricity flowing over Europe from N.E. to S.W. as in the case of Nos. 10, 23, 24, 26, 28, 36, 46, 65, 69, 71, etc. Occasionally the progress appears to be mainly from S.W. to N.E., as in the case of Nos. 58 and 70.

At other times the effect takes place simultaneously from Upsala to Milan, or at least within a period of five minutes, as in the case of Nos. 5, 7, 9, 11, 12, 13, 14, 19, 20, 29, 31, etc.

At other times it seems necessary to admit the existence of several currents moving in different directions, and probably with unequal velocities, as in the case of Nos. 15, 37, 38, 43, 45, 50, 51, 54, 57, 62, 74, etc.

Of the seventy-six cases of magnetic disturbance contained in the preceding catalogue, thirty-three occurred on days when an aurora was recorded at some one of the stations. Some of the

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deflections of the magnetic needle here recorded, were caused by the electric currents which prevail during the presence of auroras; while others occurred when no aurora was noticed. During the presence of an aurora, the magnetic deflections are greater than when there is no aurora; but they all seem to follow the same law of progress, with perhaps this exception, that during auroras there is an unusual number of cases in which there is the appearance of several currents moving simultaneously in different directions. The following is the list of auroras corresponding to dates in the catalogue.

1837. Aug. 31. 10^h P.M. Christiania. Slight aurora.
1837. Nov. 12. $6\frac{1}{2}^h$. England. Bright aurora with streamers reaching to the zenith.
Nov. 12–13. Brilliant aurora of a reddish color seen throughout France.
Nov. 13. England. Rain.
Nov. 14. England. Broad patches and streamers of a fiery red color.
Nov. 14. $11\frac{1}{2}^h$–$12\frac{1}{2}^h$. Christiania. Aurora of an intense crimson color.
1838. Jan. 28. $6\frac{1}{2}^h$–10^h. St. Petersburgh. Aurora.
1838. March 30. $9\frac{1}{2}^h$–10^h. St. Petersburgh. Aurora.
1838. Nov. 24. 10^h. Christiania. A flaming auroral arch about 10° altitude.
1839. Feb. 21. $6\frac{1}{2}^h$. Christiania. Aurora radiating towards the zenith.
1839. Aug. 30. 8^h–9^h. St. Petersburgh. Aurora.
1840. Aug. 28. 10^h. Christiania. Slight aurora.
1841. Aug. 27. 9^h–12^h. Christiania. Slight aurora.

During the aurora of Sept. 2, 1859, the disturbance of the magnetic needle was very great at Toronto, Greenwich, Brussels, Paris, Rome, Christiania, St. Petersburg, Catherinenburg, Nertchinsk, and Barnaul, but the observations are not reported with sufficient frequency to enable us to trace satisfactorily the progress of any single wave.

At Rome the greatest easterly deflection of the needle is said to have taken place Sept. 1st, at $7^h\ 20^m$ A. M. Göttingen time. At Petersburgh it took place at $7^h\ 48^m$ A. M. Göttingen time; and at Catherinenburg, Nertchinsk and Barnaul, it certainly took place within an hour of the same instant; it being impossible to determine the coincidence more closely, for the observations at these three places are only given at intervals of one hour.

New Haven, September, 1861.

ART. XXXVII.—*On the evidence furnished by Photography as to the nature of the markings on the Pleurosigma Angulatum;* by Prof. O. N. ROOD, of Troy, New York.

IT is well known that the delicate markings on this infusorial shell have been diligently studied by microscopists for more than ten years, still the form of the dots is made a subject of dispute, one party maintaining it to be hexagonal, while their antagonists insist that it is circular. Photography has been called upon to aid in a settlement, and photographs of this shell were obtained by Mr. Whenam, which distinctly exhibited the *hexagonal* structure.

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Without taking any particular interest in the controversy, I have devoted some time to photographing this test object, and have lately succeeded in obtaining, by the method indicated in my article in the September No. of this Journal, a fine, intense, sharp negative, magnified 1000 diameters.

Almost the whole shell was nearly in focus, a large portion being in very accurate focus. When this negative was examined by the microscope, the dots were seen to be distinctly *circular*, and well-defined; by the aid of photography an enlarged and sharp negative was obtained, (magnified 7000 diameters) which yielded good prints on paper, showing the markings to be circular.

The dots in these negatives were not uniformly shaded but presented an appearance like that seen in the diagram, fig. 1. Furthermore, although the interior dark circle seemed to the eye uniformly dark, this was not actually the case, as was demonstrated by copying the negative with the camera and varying the time of exposure, when it became evident that the deposit of silver grew regularly denser from the circumference to the centre of these little circles; thus in this process positive prints on glass were obtained by the camera presenting the appearance roughly indicated in fig. 2.

1.



2.



Mr. Whenam states, that he has ascertained by a $\frac{1}{15}$, that the markings on this test object are due to spherical particles of quartz; it would appear that the results here detailed favor this view.

As will readily be comprehended by photographers, the delicate *shading*, which has been described, though very distinct on glass, *cannot be seen in prints on paper*, for exactly the same reason that the delicate shades in ambrotypes are lost, when an attempt is made to obtain prints on paper from them.

The production of *hexagonal* markings, which are often obtained, is probably due to a slight defect in the focal adjustment, as well as to a slight inequality in the oblique annular illumination.

The following is an instructive experiment: in a plate of brass a large number of circular holes are drilled, their disposition, &c. being similar to that of the circular dots on the shell in question; the plate is then carefully blackened. In my experiment the plate was a copy of an enlarged negative. The plate thus patiently prepared is placed before a bright light and the photographic camera leveled at it, a distance being selected such that small images of the circular holes are obtained. The full aperture of the lens should be employed.

By varying the focal adjustment of the camera slightly, these true circles become converted into tolerable hexagons, rhombs, or triangles, the latter being less distinctly marked than the two former.

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Also, by altering the focus, an apparent reversal of the lights and shades takes place, the positions of the bright circular dots being seemingly occupied by dark dots; this is caused by the expansion of the thicker portions of the dark spaces between the circles, and so far as I can judge, with the means at my command, the reversal of the lights and shades in the dots on this test object examined by the microscope, under the imperfect focal adjustment, is due to the same cause, and is more apparent than real.

As it is impracticable to publish prints from these negatives in this Journal, samples will be sent, on application by letter, to those who may be particularly interested in this subject.

Troy, September 7th, 1861.

Art. XXXVIII.—*Waterglass;* by J. M. Ordway.

(Continued from page 165.)

Part II.

Properties.—Like some other substances whose constituents unite in a series of proportions, the alkaline silicates are rather trying to those who would square everything to exact atomic ratios. There are no fixed points certainly known by which we may make out a set of exact combinations, the intermediate compounds being considered as mixtures. Hence, though it is sometimes convenient to speak of sesquisilicates, bisilicates, and so on, these terms are to be looked upon as only approximative and analogical. It may be allowable, in order to convey to the mind a more definite idea of all such products of indefinite union, to express their composition in equivalents rather than in percentages of the constituents, and yet refrain from fanciful groupings into rational formulas.

Fused waterglass is little acted on by cold water, but when pure it dissolves without much difficulty in water kept continually boiling; though the solution goes on slowly and so evenly that bits retain to the last their exact original form, the sharp angles even not being rounded. So gradual is the diminution of the particles that one unaccustomed to the article would suppose, after a few minutes boiling, that solution was not taking place. In fact, an expert chemist once reported a certain sample of pure bisilicate of soda to be insoluble. Yet I found that forty-five minutes boiling of the same silicate, in the same state of division, caused the last particles to disappear.

When solutions are wanted day after day, it saves much time and fuel not to try to dissolve completely any given quantity in a particular amount of water, but always to keep an excess of the coarsely ground silicate in the kettle and boil, with frequent

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stirring, till the liquor acquires a sufficient strength as shown by the hydrometer. If the solution is dipped out hot, either the kettle must be immediately filled again with hot water, or the glass also must be taken out and held back till the water becomes hot, otherwise the silicate is apt to stick together and adhere most obstinately to the bottom of the kettle.

When a waterglass contains a greater proportion of silica than is needed to constitute a bisilicate, its solution is the work of many hours. And silicate of soda is somewhat harder to dissolve than a corresponding silicate of potash. As the relative amount of silica is increased, the precise point at which the product ceases to be integrally soluble, has never yet been ascertained. Fuchs speaks of his original potash glass,—$\dot{K}_2\ddot{S}i_5$,—as being entirely soluble. A monosilicate is readily taken up by water at less than the boiling heat.

As was before mentioned, the solubility of any silicate is much impaired by the presence of earthy impurities; and hence a sand which contains clay, mica, feldspar, lime, or oxyd of iron, is unsuitable for the manufacture of waterglass. When a product so contaminated is treated with boiling water, the earths and metallic oxyds are mostly left behind as compound silicates; and if sulphids are present, a part of the iron remains in the state of sulphuret, giving a blackish color to the sediment. But these foreign matters are not left wholly undissolved, for waterglass has the power of taking up small quantities of most oxyds, and the solvent power increases with the strength of the solution; so that a liquor which is slightly turbid while weak, may become quite clear by concentration, and on the other hand this clear strong liquid is rendered turbid again by large dilution. If iron is contained in the original materials, or if the melted mass is stirred with iron tools, or if the solution is effected in an iron kettle, iron can be detected in the perfectly transparent filtered liquid; and I have never yet succeeded in finding any means of getting entirely rid of this contamination. Changing protoxyd into peroxyd is of no avail, and an alkaline sulphid throws down only a part of it. From dry silicate of soda colored with manganese, I have obtained a decidedly pink liquid by boiling with water and filtering.* When a few drops of a weak solution of a metallic salt are added to waterglass and the whole is well agitated, the precipitate first formed will mostly or entirely disappear. A liquid silicate thus takes up no inconsiderable amount of the oxyds of iron, zinc, manganese, tin, lead, copper, and mercury. With protosulphate of iron and silicate of

* Kuhlmann mentions a soluble double silicate of potash and manganese. "C'est une matière vitreuse d'un violet foncé, qui donne une dissolution brune." "L'oxide de cobalt se combine aussi, mais en plus petite quantité, avec le silicate de potasse." —*Silicatisation*, 3me edition, Paris, 1858, p. 17.

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soda well shaken in a bottle partly full of air, and afterwards filtered, I have obtained a very deep blue solution. Waterglass saturated in the same way with zinc, after a while deposits the zinc again, or even coagulates into a gelatinous mass. Zincate of soda mixed with cold silicate at first shows no change, but a precipitate forms very soon. In like manner aluminate and glucinate of soda speedily cause a precipitation. But manganate, stannate, and chromate produce no alteration. Bolley* observed some years ago that even lime, magnesia, and baryta are slightly soluble in waterglass.

Thus we see that silica, though it has no neutralizing power, exhibits some reactions which go to vindicate its acid nature. But its chemical activity is more distinctly shown when earthy or metallic protoxyds in the state of hydrates are mixed, in equivalent quantities, with dissolved waterglass. In most such cases there is a speedy coagulation and the viscosity of the silicate is destroyed. The effect is very striking when we stir milk of lime into a tolerably strong solution of waterglass. The mixture almost immediately thickens or 'sets,' and it becomes crumbly, if the stirring is forcibly kept up. In solutions too dilute to set, the silicate of lime forms an exceedingly bulky precipitate. And here it may be remarked that the recommendations which have sometimes been made for recovering caustic potash or soda from the soluble silicates by adding lime, must have been given *a priori* and not after actual experiment. For the resulting silicate of lime is so voluminous and retentive of liquor, that the separation of the alkali by filtration or washing is utterly impracticable. The extraction can be effected only by drying down the mixture and then lixiviating the dehydrated mass.

Litharge, when ground exceedingly fine with water, coagulates a silicate, but does not entirely destroy the toughness, especially of silicate of potash.

The anhydrous oxyds of zinc, mercury, and copper may be mixed with waterglass without producing any apparent change, but there is reason to suppose that a union takes place in the course of time. The same is true of the hydrates of the sesquioxyds of iron, aluminium and chromium.

Of course most earthy and metallic salts effect a double decomposition when mixed with alkaline silicates, and generally a thickening of the whole mass very soon ensues. But sulphate and carbonate of baryta seem to be without action; and so does fluorid of calcium. Most of the lime salts however, whether soluble or insoluble, are particularly energetic in their operation.†

* Kopp and Will's Jahresbericht for 1858, p. 140.

† Pelouze says that even common glass on being boiled with sulphate of lime, yields no inconsiderable amount of sulphate of soda.—Leibig and Kopp's Jahresbericht for 1856,—p. 355.

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Carbonate of lime does not produce any decided change, yet when it is boiled with a very silicious silicate it becomes flocculent, showing that there is a partial exchange of constituents.

The basic carbonates of zinc and magnesia, and the carbonates of lead and manganese produce an immediate coagulation. The carbonates of ammonia and the bicarbonates of potash and soda, by virtue of their weakly bound carbonic acid, cause an instantaneous thickening in strong solutions of the silicates.

A highly silicious waterglass gives precipitates with the alkaline carbonates, acetates, tartrates, phosphates, nitrates, sulphates, and chlorids, the exact nature of which has never yet been ascertained. But the bisilcates, as well as those still more alkaline, are not affected by carbonate, tartrate, nitrate, or sulphate of soda; while sesquisilicate of soda is troubled only by a very strong solution of chlorid of sodium. The precipitate with chlorid of sodium in any case appears to be a double combination of silicate and chlorid, which is insoluble in water, but is readily decomposed by an acid. It is opaque and very voluminous, though after being washed and dried it is found to amount to only a small proportion of the quantities mixed.

Ammonia salts throw down the silica from a strong solution of waterglass, while the ammonia is set free, silicate of ammonia being a compound apparently incapable of more than a momentary existence under the ordinary pressure of the atmosphere.

When a dilute acid is added to a weak solution of a silicate there is no immediate precipitation of silica, but after some hours the whole gelatinizes. With sulphuric acid the coagulation comes on soon; but with chlorhydric acid the change is delayed a long time, and the mixture may sometimes even be heated and partially evaporated and still remain liquid.

Alcohol and wood spirit precipitate the silicates as such, even when the solutions are very weak. Fuchs recommends as a good means of purifying potash waterglass and obtaining it in a nearly solid state, to mix a strong solution with one-fourth its volume of rectified spirit of wine. The precipitate is at first bulky and opaque, but by standing a day or two it contracts and becomes firm and transparent. He says further that "soda waterglass is not at once perfectly precipitated, like potash waterglass, by rectified spirit of wine, but is only changed to a slimy mass; if it is not perfectly saturated with silica and is somewhat diluted, it either gives no precipitate, or gives one only after some time, whereby it can be easily recognized and distinguished from potash waterglass." My own experiments on precipitation by alcohol,—the details of which must be reserved for a future paper,—show that this statement is much too broad. For silicate of soda is thrown down even more readily and completely than silicate of potash. The deposit is always softer, indeed, than that from a corresponding potash compound, but

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while it is sometimes in the liquid state, under other circumstances it may constitute a firm, almost solid mass. And on the other hand, a pretty alkaline potash silicate may be precipitated in the fluid form. These products usually contain about fifty per cent of water, and are somewhat less alkaline, and considerably freer from foreign salts than the silicates from which they have been derived. And in most cases, they dissolve readily in cold water.

Very few combinations of silica and alkalies have been found capable of crystallization. Fritzsche* obtained the sesquibasic silicate of soda in the form of rectangular prisms of the composition $\dot{N}a_3\,\ddot{S}i_2\,\dot{H}_{27}$; also the same salt under another form with 18 eqs. of water. And Yorke† mentions crystals containing 21 eqs. of water. Fremy‡ reports the singular compounds $\dot{K}_4\,\ddot{S}i_3 + Aq.$ and $\dot{N}a_4\,\ddot{S}i_3\,\dot{H}_{26}$ to be easily crystallizable, and he thinks the latter was what Fritzsche really produced. Fremy§ also speaks of the soluble trisilicates,—$\dot{K}\ddot{S}i_3 + Aq.$ and $\dot{N}a\,\ddot{S}i_3\,\dot{H}_{20}$,—as crystallizable. The details of his researches, however, have not been published, and we know not on what grounds he makes a statement so much at variance with what the character of the other acid silicates would lead us to expect. For nothing between the monosilicates and the trisilicates shows the slightest disposition to assume the crystalline form. On the contrary, as the relative proportion of acid is increased beyond a sesquibasic silicate, the product takes on an increasingly gummy or viscous character. And one of the most important properties of true waterglass is its adhesiveness,—a quality which it possesses in a degree not approached by any other inorganic substance. In this respect silicate of soda somewhat surpasses silicate of potash; for when the soda silicate is boiled down till it begins to adhere to the bottom of the dish, it still remains a strongly cohesive liquid. While silicate of potash similarly treated, is fluid and glutinous at first, but in the course of a day or two, becomes a slightly tenacious jelly. With the exception of this last trifling change, solutions of waterglass, of whatever strength they may be, if kept from the air and from frost, remain unaltered for years. When they are exposed to intense cold, a part of the water freezes, but reunites on thawing.

When a concentrated silicate is spread out so as to present a large surface to the air, it very gradually dries and becomes unimpressible, but does not part with all its water and acquire a stony hardness except as the alkali becomes carbonated. Fuchs found an air dried potash waterglass to contain twelve per cent of water. This must have been extended in very thin layers, for a stratum of bisilcate of potash, about a quarter of an inch

* Berzelius, Traité de Chimie,—Ed. Française, 2e, iii, p. 233.
† Kopp and Will's Jahresbericht for 1857, p. 162.
‡ Comptes Rendus, xliii, p. 1148. § Id. p. 1147.

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in thickness, which I left on paper in a very dry loft for more than two years, still retained 29 per cent of water and was capable of bending under a steady, protracted pressure.

To expel the last portions of water directly, requires a heat approaching to redness; and the puffy, dehydrated mass is no longer entirely soluble in water. Fuchs attributes the passiveness of the silica in this case to the absorption of carbonic acid in drying down, and says that if the anhydrous mass is heated to full redness so as to decompose the carbonate, the solubility is restored. It is indeed true that when waterglass is desiccated in an open dish over a lamp, it cannot remain unaffected by the products of combustion, and the residue will effervesce with acids. There are also two other possible sources of carbonic acid. It may have been taken up from the air in first dissolving the silicate, or in preserving the liquid in imperfectly closed vessels. And again if the solution has not been made with perfectly pure water, or if it has been exposed to falling dust, it is likely to contain organic matter which on being strongly heated in the presence of an alkali, is resolved into the simplest products of decomposition.

All these possible chances of influence seem to have been disregarded by Lielegg,* in examining a liquid bisilicate of soda made at Munich. To determine the water, he kept some of the solution a long time in an air bath at a temperature between 90° and 100° C., and then slowly raised the heat to dull redness. On digesting the mass with warm water there was left a residue which proved to be silica, while a sesquisilicate,—$\dot{N}a_6\,\ddot{S}i_7$,—was dissolved. He hence concludes that at a red heat bisilicate of soda cannot exist, but is resolved into silica and a salt of constant composition, a sesquisilicate. But the facts by no means justify his inference. Besides neglecting the effects of carbonic acid,—and drying in an air bath would give a full opportunity for absorption,—Lielegg fails to notice that the sesquisilicate itself relinquishes a part of its acid in parting with its water. It will hardly do to make the broad statement that bisilicate of soda cannot exist at a red heat, when a pure bisilicate made in the dry way, and of course cooled down through the "Glühhitze," is completely soluble; and it would be absurd to consider that which dissolves without any perceptible resolution into parts, as consisting of sesquisilicate and soluble silica. Taking everything into account, we are warranted in affirming only that when dissolved waterglass is rendered anhydrous by exposure to the necessary heat, a part of the silica goes over into the passive state. And I find this to be true even when especial pains are taken to preclude every source of carbonic acid. The reason remains to be discovered. Fremy† found that after the trisilicates

* Dingler's Polytech. Journal,—cliii, p. 49.

† Liebig and Kopp's Jahresbericht for 1856, p. 353.

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had been carefully dried, water dissolves the alkali out of the residue, and leaves the silica, which last, according as the strength of the heat has been, is or is not soluble in dilute alkalies. The sesquisilicates also he proved to be decomposable by heat, but the monosilicates were ascertained to be unchanged by dehydratation.

Uses.—Numerous applications have been proposed for waterglass, and for many purposes it has really proved to be of permanent value, but the cases in which there are not material drawbacks to its employment, are very few. The properties which render it available in the arts, are:—

1. Its adhesiveness in the hydrated state. 2. Its vitrifying power in the dry state. 3. Its alkaline nature. 4. Its capability of yielding soluble silica. 5. Its peculiar chemical relations as a whole.

1. Adhesiveness. On account of this most striking characteristic of waterglass, its discoverer said that it might justly be called "mineral glue," and to a certain extent the similarity holds good. It differs however from glue, and most other cementing substances, in continuing to shrink after it has become apparently dry. A strong silicate of soda solution forms a good colorless cement for glass, porcelain, and stone, but when shut up in such impervious substances, it is very slow in becoming water proof, and as it does so, its strength is much impaired. For wood and other porous materials it does not answer, since they allow the access of air which, by its carbonic acid, decomposes the silicate and destroys its tenacity. I have tried silicate of soda in the laboratory for pasting labels on glass bottles. It does pretty well, only when it is once on, it will never wash off, though the paper itself may be removed by washing. It possesses no advantages over gum or flour paste, with the single exception of not being liable to mould by keeping.

I have often made use of a strong solution of waterglass mixed with clay and sand, for setting fire bricks. Such a mixture undergoes partial fusion in a strong heat, and makes very tight, firm joints. For brick work that is to be kept moderately hot, a mortar composed of the same ingredients, but with a larger proportion of the silicate, makes an excellent cement which continues hard and tough, while lime mortar exposed to heat, is apt to dry up and lose its binding power. Mr. Joseph D. Gould tells me that he has found fibrous asbestos wet with a strong silicate of soda liquor to make a most excellent packing for the joints of apparatus exposed to hot acid vapors.

When liquid waterglass, either by itself or mixed with an inert substance, is thinly spread out on any surface, it dries to a strongly adherent, hard, transparent varnish; but it still goes on absorbing carbonic acid from the air, and the residual silica

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being quite incapable of extension, becomes traversed with an infinity of minute cracks, so that the original smoothness and clearness are greatly diminished. Still the adhesion continues and the silicious coating can no longer be removed by washing with water. Hence the soluble silicates are adapted to fix various pigments. In fact this was the first use to which they were made subservient, and they have latterly been much employed in Europe for painting. When waterglass mixed with the lighter colors is applied to wood, the alkaline nature of the vehicle betrays itself by a softening and discoloration of the surface, which effects however are quite inconsiderable, if the wood is new and clean. Another difficulty is that the fixed coating having no elasticity, cannot accommodate itself, like an oily or resinous film, to the expansions and contractions of the wood in wet and dry weather, nor yet to slight inequalities of shrinkage. Still waterglass paint may do well in places where it is not exposed to alternations of dampness and dryness. And for outbuildings, fences, and bridges,—smoothness being of little importance,—a mixture of zinc white, chalk, ochre, or terra di Sienna with silicate of soda, might in many cases, be substituted for the easily detached lime washes so commonly used in this country.

Fuchs at first made and applied waterglass to render wood incapable of being inflamed, and experiments instituted by order of the British admiralty are said to have proved its efficacy in this respect.* Better antiphlogistics may have been found, but none of them are capable of serving at the same time as varnishes.

We are told by some that a silicate secures wood against the destructive effects of air and moisture, an assertion which savors a little of enthusiasm, and admits of a reasonable doubt. Since waterglass can do little toward permanently excluding air and moisture, and as little toward counteracting albuminous matters within the wood, its preservative power must be far inferior to that of oil, and no greater than that of lime whitewash. In estimating the value of silicate of potash or soda for any such use, we must not be deceived by the smooth, glassy, continuous, impenetrable coat which it forms at first. Its smoothness, its lustre, its continuity, its imperviousness are all destined to pass away by the slow action of the atmosphere. Indeed the value of waterglass in painting depends in some measure on its alterability by carbonic acid, since when first dried it is still soluble in water, and only after having been exposed to the air for several days, is it safe from moisture or rain. The fixation is sometimes hastened by brushing over the coating of silicate, after a day or two, with a weak solution of sal-ammoniac or of carbonate of ammonia.

* Répertoire de Chimie Appliquée, i, 68.

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Silicate paint, being itself unyielding, is much more suitable for unyielding surfaces, as for glass, stone, or brick, or for walls plastered with lime mortar. As it unites more intimately with such substances, it is less liable to scale off from them than from wood. But to guard against a loose adhesion, it is better in all cases, to paint with a very thin waterglass several times, allowing some days to elapse between the successive applications, rather than to use a strong solution once. The thinner silicate penetrates deeper and takes a surer hold. It is also sooner and more uniformly fixed by the absorption of carbonic acid.

Many pigments are incompatible with waterglass, and must be rejected. Such are white lead, Prussian blue, Schweinfurth green, and animal or vegetable colors. But there is still left a sufficient variety to select from, as we may take zinc white,* chalk, sulphate of baryta, yellow ochre, cadmium yellow, Venetian red, terra di Sienna, green oxyd of chrome, umber, ultramarine, lampblack, or bone black. It is said that chrome yellow and chrome red may also be used, but it would be safer to leave them out, as their chemical relations indicate their unsuitableness. Before applying colors ground up with waterglass, it is best to 'prime' the surface with simple silicate liquor, and let it stand 24 hours or more. This fills the pores and makes a ground to which the paint afterwards laid on, will adhere more firmly. A solution of silicate of soda for paint or for priming, should not exceed the sp. gr. 1·15 and it is better to take it much weaker. Much of the silicate of soda found in the market in this country, is unfit for paint. It is sometimes too alkaline, and is very often too much contaminated with foreign salts which are prone to crystallize and loosen the silica before it becomes properly fixed. A good silicate should be bright, transparent, homogeneous, and very light colored, and should show no special tendency to absorb moisture in a damp atmosphere. It is none the worse for requiring several hours boiling to bring it into solution, provided this refractoriness does not arise from earthy matter in combination.

Walls plastered with lime mortar, may be rendered very hard, close and smooth, as well as capable of being washed, by applying a few times a silicate, either alone, or mixed with chalk or any coloring material.

Since 1840 Fuchs has introduced a new plan of executing works of art on plastered walls, designating his method by the name of "stereochrome,"—*fast paint.* A basis is first prepared with a rather sandy lime mortar, and when this has taken up a due proportion of carbonic acid and become well set, the super-

* In one or two standard works it is stated that zinc white sets rapidly with waterglass. But this is an error. The mixture may be kept for several days without any change.

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ficial glaze of carbonate is removed, by scouring with sandstone or by washing with weak phosphoric acid. The plaster is then repeatedly soaked with a dilute solution of very silicious waterglass, the silicate being allowed to dry and fix between the consecutive drenchings. The well saturated ground is now covered with a thin stratum of nicely prepared, but meagre, mortar, and this coat is treated in the same way as the basis. When the silicatization is finished, the surface should still be rough and absorbent. If it is glazed over so as to be too impervious, Fuchs recommends to open the pores by pouring on alcohol and burning it off. On the wall so prepared, the painting is executed with colors ground up with mere water. And finally the pigments are fixed by repeated affusions of a rather alkaline double silicate of potash and soda. To avoid any displacement of the colors, the fixing liquid is thrown on the first time, in the form of a fine spray, by means of a suitable syringe. As the artist must frequently change his palette, it is impracticable to use the paints mixed directly with waterglass, since the silicate would be always drying up, and the brushes would get stiff and hard. Brushes soaked with a silicate should never be allowed to dry without being first thoroughly washed with water.

Fuchs mentions as proofs of the excellence of the stereochrome, two paintings which had been exposed out of doors to all changes of weather, for six years, and still were as bright and as fresh looking as though they had just left the artist's hand.

Creuzburg* has resorted to a modification of Fuchs' method, for common painting, and thus makes use of pigments which would otherwise be inadmissible. To any surface he applies alternately thin waterglass and a mixture of the color with skimmed milk, till the requisite body is attained. He says that it is only necessary to allow one coat to dry before laying on another, but this would be hardly consistent with a solid fixation. A final varnishing with oil is recommended, to impart lustre and prevent saline efflorescence.

Creuzburg reckons as advantages of waterglass paint:—1. Rapidity of drying. 2. Freedom from smell. 3. Purity of tint. White oil paint is modified in tone by the color of the oil, and it is farther liable to get dingy by a chemical change which goes on in the dark. 4. Durability.† 5. Resistance to fire. 6. Cheapness.

When a silicious paint is to be laid on a metallic surface, it is

* Wagner's Jahresbericht, iii, 133,

† To illustrate the short durability of oil paint Creuzburg mentions the fact that a coat of white lead and oil, after having been exposed to the weather for two years or so, is so far changed that the white lead rubs off with the greatest ease. This however is rather an extreme case, and it is said by practical men to hold true more particularly with ceruse manufactured by the Dutch method. White oxychlorid of lead and zinc white are not considered liable to this disadvantage.

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well to have the metal moderately warm, otherwise the coating is liable to crack and scale off. For stoves that are sometimes red hot, it is said that a mixture of waterglass and peroxyd of manganese, makes a good blacking not liable to burn away.

Kuhlmann has succeeded in printing wall paper with waterglass as a vehicle for the pigments. And he says that any paper printed with colors unalterable by alkalies, may be varnished with a silicate, after it has been pasted on the wall, and will afterwards bear rubbing and even washing.

Kuhlmann likewise recommends a mixture of waterglass with lampblack, ivory black, or vermilion, for a writing ink capable of resisting all destructive agents. But according to Baudrimont, after a writing executed with silicious ink, has been long exposed, the silicate having undergone decomposition, the letters may be easily erased.*

In 1840 Leykauf proposed the silicates for fixing ultramarine on cloth, thus substituting a very cheap material for the albumen and casein largely used in pigment printing.† But it can not be used for goods that are to be steamed, and in any case the alkali has to be removed by passing the printed cloth into an acid bath, which operating too rapidly must deprive the silica of most of its adhesive force. In fact though this plan was brought forward so long ago, a prize is still offered for the discovery of some cheap and efficient substitute for albumen.

The binding power of the silicates has been turned to account by Kuhlmann in the hardening or "silicatization" of soft porous stone. A tender material, like chalk, may be rendered available for building purposes by repeated saturations with waterglass. And the durability of many buildings already erected, is greatly enhanced by subjecting the outside surface to a similar treatment. The same process has been found efficacious in preserving some ancient statues freshly exhumed, which would otherwise have fallen to pieces after a short exposure to the air. Fragile palæontological specimens have also been strengthened and saved by silicatization.

Ransome says that merely washing stone with waterglass is not sufficient, as the silicate retains its solubility for a long time. He therefore thought fit to secure a patent for fixing the silica by the subsequent application of chlorid of calcium. But notwithstanding the strong commendations of interested parties, it would appear from recent discussions of the subject in London that this method has not proved entirely satisfactory. Indeed hasty fixation can hardly be compatible with tenacity and per-

* Liebig and Kopp's Jahresbericht for 1855, p. 869, note.

† As it takes 24 dozen eggs to furnish 1 kilogram of dry albumen, it has been computed that 330,000 hens are needed to produce the 125,000 kilos. of albumen consumed yearly in Alsace alone.—*Rep. Chimie, App.*—iii, p. 101.

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manence, and it is probable that the best effect would be attained by using a silicate alone, many times and at distant intervals.

Kuhlmann meets the difficulty by a plan theoretically perfect, but involving too much expense, which is to use silicate of potash and render both constituents insoluble with fluosilicic acid.

To impart a more agreeable color than some stones naturally possess, Kuhlmann impregnates them, first of all, with a salt of iron, manganese, copper, or chrome. The silicate afterwards applied precipitates the metallic oxyd within the pores and produces the desired tint, either at once or after the absorption of a farther portion of oxygen from the air.

With regard to stone, silicatization is of little importance in this country, as we have few varieties that need artificial hardening. But in some places there is a lack of good clay for brick making, and such earth as is worked, gives very tender, absorbent brick, ill calculated to bear handling and exposure to the weather. In many cases it would doubtless be advantageous to silicatize the exposed surface of the bricks after they have been laid. This is deserving of especial consideration where they are subjected to the action of sea water, which is particularly destructive of porous building materials.

In connection with painting and silicatization it should be observed that on surfaces charged with silicate of soda a whitish efflorescence of carbonate of soda, is likely to appear several times, but this can be removed as often as it forms, by gently washing with water, or out of doors the rain will carry it off.

Fuchs in his first memoir, showed the possibility of making an artificial stone with clay, sand, and a solution of silicate of soda. Such a mixture after being moulded into any desired form slowly dries to an exceedingly tough, resistant mass, but it is not waterproof. It hardens better and more uniformly when the drying is hastened by a moderate heat. A dull red heat dehydrates the silicates and renders the mass friable. It is doubtful whether an artificial stone that deserves the name, can be made without exposing the mixture, after moulding and drying, to a heat strong enough to revitrify the silicate. By such treatment the waterglass recovers its tenacity and, by forming a chemical union with the other ingredients, becomes truly insoluble. The baked ware should, of course, be slowly cooled so that the cementing material may become properly annealed.

In 1844, Ransome took out a patent in England for a stone prepared with *liquor silicum*, limestone powder, or chalk, and sand. His process is a rather expensive one, but the article produced is said to be of excellent quality. There is reason to believe that *liquor silicum*, is less suitable for such purposes than the far cheaper sesquisilicate or bisilicate of soda. In making trials in a small way I have been unable to get a good ware with

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common sand, but succeeded best with a mixture of crushed granite, chalk, or bone ashes, and strong sesquisilicate of soda. Unless a fair allowance of some absorbent substance,—like carbonate of lime, burnt bones, or roasted clay,—is used, the silicate dries first on the outside and forms an impervious varnish which prevents the escape of moisture from the interior. If we resort to a weaker solution of waterglass, this dries at the surface without closing the pores, but then the liquid inside is drawn outwards by capillary attraction, and the central parts are left too meagre while the exterior is too rich in vitrifiable matter. Ransome ingeniously obviates the difficulty by heating the moulded stones in a closed space, so that the surface is in contact only with an atmosphere saturated with moisture, while the interior is acquiring such a temperature that on opening the room most of the water will pass off rapidly and keep the pores open.

Wagenmann* succeeded in making artificial meerschaum by mixing waterglass, lime, magnesia, and carbonate of magnesia, and simply drying.

Considered merely with regard to its mechanical properties, waterglass would appear very suitable to replace starch and glue as a glazing material, in many cases. In fact it was brought forward by Leigh, a year or two ago, as a substitute for starch in sizing cotton yarn for weaving, and in putting the final finish on cotton fabrics. But its chemical character indicates its unfitness for such uses. Starch after drying remains unchanged itself, and has no action on the stuffs. While a silicate is altered by exposure to the air, and loses its smoothness as well as much of its rigidity. Besides this it is alkaline, and therefore tends to weaken the fibre,—an effect which becomes at once apparent when waterglass is used strong for producing very stiff fabrics.

It is common to increase the weight and apparent substance of flimsy cloth by passing it through starch to which fine clay, chalk, or sulphate of lime has been added. In place of this preparing material so easily removed by washing, Grüne proposed to pad the cloth in silicate of soda, and then run it through a weak acid liquor, so as to precipitate silica within the fibre and make a permanent stuffing. But it should be borne in mind that weak acid acting on a weak silicate, gives a silica soluble in water. A salt of zinc or magnesia would be a more suitable precipitant. The plan, however, even were it effectual, is too troublesome and costly. A factitious body can be of little use except to make the goods sell better; and it is hardly worth the while to go to much expense for a mere deception. Most manufacturers would prefer to cheat with clay that is worth only a cent a pound, rather than with a precipitated silica that could hardly cost less than three; and most consumers would rather have the three extra cents appropriated to extra cotton.

* Wagner's Jahresbericht, ii, 118.

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As a thick solution of waterglass dries at first to a glassy, impenetrable varnish, Grüne has suggested its employment as a resist in calico-printing;—that is, as a substance to cover those parts of the cloth that are to remain white, and prevent them from imbibing the dyeing liquor. But hot water dissolves the silicate rapidly, and hence such a resist can answer only when the printed cloth is to be immersed for a very short time in cold dyeing baths.

In the manufacture of porcelain wares, pastes are sometimes used that are devoid of plasticity and requires the addition of some glutinous material to give them sufficient cohesiveness to allow them to be moulded. For such pastes "mineral glue" would probably do better than a destructible mucilage.

2. In fusibility and fluxing power waterglass greatly resembles borax, and in some cases may well replace this expensive salt. The iron hoes employed in stirring the fused silicate during its preparation are kept remarkably clean and bright by the melted mass, and this naturally suggests its use in cleansing and protecting heated metallic surfaces. Indeed according to Wagner,* the double silicate of potash and soda,—which melts more readily than simple silicate,—forms a good substitute for borax in brazing and in welding. He rather injudiciously recommends the mixed materials instead of the ready formed glass.

Another application which has proved successful and has been patented in this country, is the manufacture of wick for snuffless candles. By passing the wickyarn through silicate of soda and then through acetate of lead, it is charged with enough silicate of lead to vitrify all the ash as the candle burns away.

Recently an English patent has been issued, for treating cloth and paper in the same way,—but with stronger solutions,—in order to render them uninflammable.

Leibl† long ago recommended a solution of waterglass as a glaze for pottery ware, to be applied before the burning. It has the advantage of being free from lead, and as it penetrates farther into the body of the ware than any flux insoluble in water, it should take a firmer hold. It is said however that Leibl's glaze has been tried with unfavorable results, but it is quite possible that the experiments were not properly conducted.

Though sulphate of soda is exceedingly cheap in this country, and sulphate of potash, abundantly obtained in refining pearlash, finds sale only at a very low price to alum makers, our glass manufacturers generally employ only the carbonates. I have long sought to produce purified alkaline silicates that might economically replace the carbonates in making the better qualities of glass, but have been met by a hitherto insurmountable difficulty. The alkaline sulphates can be decomposed by silica and

* Wagner's Jahresbericht, iii, 137. † Id., ii, p. 211.

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coal much more easily and certainly in a reverberatory furnace than in a glass pot, and with sulphates freed from iron, pure silicates of potash and soda could be made with far greater facility than the carbonates. When a clean sulphate is converted into waterglass and this is dissolved, the few impurities derived from the furnace and from the fuel, are left behind. If we concentrate the clear solution and stir into it rapidly a thick, smooth milk of lime, the mixture soon sets and crumbles, and the whole mass can be dried down with ease. The resulting double silicate mixed with the requisite quantity of sand, fuses in less time than the ordinary glass mixture, and boils up but very little. Precipitated dicarbonate of zinc, ceruse, or litharge may be substituted for lime. The litharge mixture however toughens after coagulation, and is harder to reduce to dryness.

But economy will not allow the purification of both the material and the silicate made from it. It is in using crude sulphate and applying the refining process to the waterglass only, that the difficulty above mentioned occurs. When iron is contained in the fused silicate, a little of it will enter into solution, and there has yet been found no means of throwing it down. This dissolved iron therefore is carried forward into the glass and imparts too much greenness to be overcome by any reasonable amount of correctives. A small quantity of arseniate of soda, oxyd of antimony, or stannic acid lessens the color, but does not entirely remove it.

It would seem therefore that the only available way of adapting waterglass to the glass manufacture, is to start with purified materials and make a product which can be directly fluxed with proper proportions of sand and lime or litharge.

Were it desirable to introduce baryta into glass, a suitable material in the form of a double silicate of baryta and potash or soda, could be easily prepared from the pure sulphates. But lime is much cheaper than baryta in any form, and as to toughness and brilliancy I have found on trial in the small way very little difference between a glass made with lime and one containing an equivalent amount of baryta. Neither does zinc glass possess much advantage, in any respect, over an equally pure lime glass.

Some years ago, with the idea of effecting a saving in pearlash, precipitated carbonate of baryta was largely used by some manufacturers of lead glass, the price being about half that of litharge. They did not stop to consider that one equivalent of lead and one of pure lime would go much farther than two equivalents of baryta in increasing the lustre and fusibility of glass, and add no more to the cost.

3. As a source of soluble silica waterglass may prove valuable in agriculture, and years ago it was proposed for a manure. Then its high price was a serious objection, but now it has become a

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common article of manufacture, and competition has reduced the price to less than that of Peruvian guano. Indeed were there a large demand, a silicate of soda suitable for manure could be made from the sulphate and sold in this country for two cents a pound, and yet yield a liberal profit to the manufacturer.

If waterglass is used in solution, it ought to be applied to the growing crops by frequent waterings. But perhaps the better way would be to spread the finely ground, dry silicate mixed with other manures, and thus supply to the soil a material similar to its feldspathic ingredients, but far more susceptible of decomposition. One or two agricultural experiments do not suffice to establish any particular point, and we have as yet too few accounts of the effects produced by using silicate of soda, to enable us to decide as to its real practical value to the farmer.

There is another application in which waterglass acts as a purveyor of soluble silica. According to Kuhlmann common lime mortar may be rendered hydraulic by the addition of a few per cent of dry, pulverized silicate of potash or soda, and poor cements can, by the same means, be made equal to the best. A solution of waterglass will not answer the purpose so well, because it sets before the mortar can be got into its place. Still Kuhlmann recommends both the fine powder and the solution. He even attributes the peculiar character of hydraulic cements to the alkaline silicate naturally present in them, but his views have not been fully substantiated.

4. In the dissolved silicates we have an alkali whose causticity is blunted by a very feeble acid, and their similarity in this respect to the oleostearates, suggests their employment in the place of soap. Waterglass has indeed great cleansing power, and, as far as mere chemical effect is concerned, it should in most cases answer the purpose of soap. But the peculiar value of soap depends in no small degree on its mechanical action. The emulsive, as well as the solvent power, comes into play, and in many instances that soap is found most suitable that froths most. Waterglass shows little tendency to form an intimate mixture with oily substances, nor has it any disposition to foam. Soap leaves washed articles soft, while the silicate imparts an unpleasant harshness. Hence silicate of soda is objectionable for scouring wool and woolen or mixed fabrics. It is indeed better for washing or scouring, than a caustic alkali, since it does not have the same peculiar shrivelling effect on animal or vegetable substances. But it possesses little advantage over neutral carbonate of soda, in any respect. For cleaning paint however the silicate is said to be better than any thing else. Waterglass has been extensively tried against soap in large bleaching, dyeing, and printing establishments and in laundries, but though some say it does well enough, the reports are generally unfavorable.*

* Wagner's Jahresbericht, iv, 172.

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Patents have been obtained for soaps containing an admixture of silicate of soda, but until we have some proof that there is really anything to be gained by using such soaps, they are entitled to only a passing notice. I have made experiments to determine whether caustic soda could be economically made from the silicate, and the answer was decidedly in the negative.

5. Silicate of soda, on account of its chemical relations, has come into general use as a substitute for phosphate or arseniate of soda in dunging printed calicoes. This, the most important of all the applications, was patented in England by Jäger in 1852. The silicate by itself, however, was found to be too alkaline, and liable to dissolve away the aluminous mordants. Probably the article tried by many was not silicious enough, for if used alone, it ought to contain at least two equivalents of silica to one of soda. But such a silicate is very hard to dissolve, and what is prepared by chemical manufacturers, is commonly a sesquisilicate. Indeed Jäger himself prescribes such proportions as would form a sesquisilicate. In 1854 Higgin introduced a great improvement by substituting for waterglass the highly voluminous lime silicate formed by adding to silicate of soda, in the dunging vat, a sufficient quantity of chlorid of calcium to effect a complete double decomposition. This plan renders it perfectly safe to take the easily dissolved sesquisilicate of soda; and now waterglass has almost entirely superseded other dunging materials, being cheaper than any other substance, and in most cases giving perfect satisfaction. It is possible that in those few instances in which it has been rejected, due attention to the quality of the articles employed, would remove all difficulties. The fact that the alkaline silicates dissolve the protoxyd of iron, has been overlooked, and the manufacturer does not always take pains to peroxydize all the iron in the fused mass.

I have known an instance in which a lime salt was used, that happened to contain tarry matter and iron, and some pieces of cloth dunged with the mixture came out of the dyeing vat with the colors essentially degraded from the desired tints. It is reasonable to suppose then that a slight saddening of the bright colors, may result from taking a silicate that is brown, and allows dissolved protoxyd or sulphid of iron to go into the dunging mixture. And then again commercial muriatic acid often contains a reducing agent, sulphurous acid, and as some neutralize with chalk, which is always ferruginous, protochlorid of iron may be left in the lime solution. The chlorid of calcium should be made with milk of lime added in excess so as to insure the removal of every trace of iron. Pure salts of zinc, magnesia, or even of ammonia, would perhaps act as well as chlorid of calcium, but in most cases this is the cheapest substance to be had.

From peroxyd of iron, which has much less affinity for other

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bodies than the protoxyd, we have little to fear. In fact were the dunging bath free from the sesquioxyd to start with, it could not remain so, as it is continually receiving from the cloth the excess of the iron mordants.

According to Grüne,* silicate of soda may be made serviceable in dyeing cotton, since with its use cheaper mordants may be substituted for the acetates of alumina, iron, and tin. He pads the stuffs in a weak solution of waterglass, then passes them through alum, copperas, or protochlorid of tin, and after rinsing, colors them with any suitable dye-stuff. But his idea that silica contributes to the fastness of the colors, is hardly tenable. It is true that precipitated silica, under some circumstances, dries to a dense mass like sand, but when earths or oxyds are present, it more commonly takes the form of a very light, loose powder, and in this state, it can exert no protective power. If silica in fixing mordants forms a coating that resists acids and soaps, we might expect that after having once been dried, the cloth would be slow to receive the coloring matter itself. Yet printed calico dyes very well months after it has been dunged with waterglass. What little silica remains combined with mordants can be of little service further than to retain the oxyds in the active state.

There has lately appeared in the market, for the use of calico-printers, a substance professing to be more valuable than common waterglass, because it is a compound of silicate and arseniate of soda. A sample of it was found to contain, besides the silicate, 4·5 per cent of sulphate of soda, 3·4 per cent chlorid of sodium, and only 7·6 per cent of arseniate. But as sometimes more, sometimes less arsenic will be volatilized during the fusion of the ingredients, it would be difficult to make such a mixture of uniform composition. And then, too, seven or eight per cent of arseniate in the product, can have no special influence; or if it had, the printer might as well add a regular proportion of arseniate to the silicate solution, as pay an extra price for he knows not what.

Another absurd proposition which has been advanced by those wishing to monopolize the manufacture, is that a silicate containing an admixture of sulphate and chlorid, is superior to the pure article. There can be no reason assigned why it should be so, and as to experience, so far as I can learn, pure well worked waterglass has always given quite as good satisfaction in dunging calico, as either the arseniated silicate, or the uncertain, half made product prepared from impure soda ash. It has never yet been ascertained what is the precise reaction between the silicate of soda or lime and the mordant on the cloth. There can be little doubt that a silicate of alumina or iron is formed, and it is not improbable that this retains a small amount of lime or soda.

Manchester, N. H., August, 1861.

* Wagner's Jahresbericht, i, pp. 339, 340.

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ART. XXXIX.—*On the Fossil Fruits found in connection with the Lignites of Brandon, Vt.;* by LEO LESQUEREUX.

PROF. EDWARD HITCHCOCK (this Journal, 2d series, vol. xv, pag. 95–104,) has already given excellent descriptions accompanied with drawings, of the Brandon fruits and most satisfactory details concerning the strata with which they are connected. I owe to the celebrated Professor of Amherst College not only the communication of the original specimens from which the drawings have been made, but also a number of corresponding specimens that he had the kindness to present to me.

It cannot be expected that the examination I have been requested to make of these fruits can afford any exact botanical determinations. Indeed an accurate analysis of fossil plants is mostly impossible, their form being generally more or less obliterated and the preserved part, the hardest of course, being often of slight value, as a botanical character. By cutting a few specimens, I was enabled to find some details of anatomical structure in one of the species only, and thus to mark its botanical characters somewhat more accurately than it is generally done for fossil fruits. It is then only to point out the relation of some of the Brandon fruits with fossil species found elsewhere, or with genera of plants still living, and especially to try to come to a satisfactory understanding about the geological age of the lignite deposit where they are found, that the few following remarks are made:*

To facilitate further quotations and discussions about the Brandon fruits, I think that it is also convenient to give a short description of their essential characters and to name them.

* The numbers marked in this paper correspond with those of the still unedited report of Vermont by Prof. Ed. Hitchcock. As they are not the same as some of the Journal, (loc. cit.) it is necessary to correlate them.

This Jour.,	Fig. 1	is equivalent to	Fig. 111	to 117 of the Report.
"	" 2	"	118	"
"	" 3	"	119	"
"	" 4	"	132	"
"	" 5	"	133	"
"	" 6	"	123	"
"	" 7	"	145	"
"	" 8	"	142	"
"	" 9	"	146	"
"	" 10	"	134	"
"	" 11	"	136	"
"	" 12	"	126	"
"	" 13	"	153	"
"	" 14	"	154	"
"	" 15	"	151	"
"	" 16	"	148	"
"	" 17	"	149	"
"	" 18 and 19	"	150	"
"	" 20	"	159	"

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No. 1. *Carpolithes Brandoniana*, sp. nov. Capsule thick-walled, oval or nearly round, flattened, obtuse at both ends, valvate. Valves obscurely pointed, opening from the base to half the length of the capsule.

Var. *α*, elongata. Fig. 111 to 113.
Var. *β*, obtusa. Fig. 114 to 117.

Specimens figured 111 to 117 are certainly various forms of the same species and I think that those of 118, 119 and 124 ought to be referred to the same genus.

No. 2. *Carpolithes fissilis*, sp. nov. (Fig. 118, 119 and 124.) Capsule, a little flattened, ovate, lanceolate, obtuse or rounded at one end, pointed at the other, obscurely tencostate, irregularly tri-valved, dehiscent or closed. In this species as in the former, the size of the fruit varies from one to two inches in length and from half an inch to one inch or a little more in breadth.

Nothing like the fruits of these two species has been before published by palæontologists. The only fossil fruit to which they might be compared is the capsule of an *Embothrium* (Heer, Flor. tert. Helv., pl. 93, fig. 30,) and especially that of *Embothrium salignum*, a living species of the *Proteaceæ* family, a figure of which is given by the same author on the same plate. But the fruits of the genus *Embothrium* are borne on a strong woody stem generally preserved in the fossil state, while our fossil fruits of Brandon have no scars showing the point of attachment to a pedicel. They both, on the contrary, appear to have been enclosed, either in the spathe, or a fibrous capsule, like the fruits of some palms, or partly immersed in a cupula, like those of some *Cupuliferæ*. It may be that the thick, fibrous and woody capsule contained originally some seeds that have escaped by the dehiscence of the valves, as Prof. E. Hitchcock remarks; but the total absence of seeds, even within unopened specimens, led me to suppose that the thin pellicle which is seen within these peculiar fruits contained a mealy cotyledon, whose form and matter have been destroyed by maceration. It is useless however to speculate on these fruits till something more is known about their relation to some living species. Specimens of No. 1 are extremely abundant at Brandon.

No. 3. *Carpolithes irregularis*, sp. nov. (Fig. 120, 121, 123, 125, and 128.) Fruit capsular, about one inch in diameter, irregularly somewhat flattened, sometimes obscurely trigonal, round-oval, costate in its length.

These may be unopened and less flattened specimens of the same species as No. 2. They would compare well with some species of *Carya*, if they were not generally a little flattened or trigonal. Perhaps fig. 128 belongs to another species; but it looks like a deformed specimen of this.

No. 4. *Carpolithes Grayana*, sp. nov. (Fig. 122.) Fruit oval-elongated, obtuse at one end, marked by a sharp abrupt point

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at the other, a little flattened, one inch long, less than an inch broad, obscurely costate.

This species has just the form of the kernel of the almond. It is nearly related to *Carpolithes pruniformis* Heer, (l. c. vol. iii, p. 139, tab. 141, fig. 18 to 30,) abundant in the upper tertiary of Europe, especially at Œningen.

No. 5. *Carya verrucosa*, sp. nov. (Fig. 129.) Fruit oval, slightly costate, obtuse at both ends, warty.

This fruit is like *Carya Brauniana* Heer, (l. c., vol. iii, p. 93, tab. 127, fig. 50 and 51) from Œningen. It is a little larger than the following, but may be the same species still covered with the husk.

No. 6. *Carya Vermontana*, sp. nov. (Fig. 130.) Nut small, about half an inch long, oval, pointed at one end, obtuse at the other, six-costate.

It is extremely like *Carya Bruckmanni* Heer, (loc. cit., vol. iii, pag. 93, tab. 127, fig. 32) perhaps identical with it, also from Œningen, like the former.

No. 7. *Fagus Hitchcockii*, sp. nov. (Fig. 126 and 127.) Nut large, trigonal, with the angles somewhat obtuse, striated on the sides.

The fruit has nearly the same form as a nutlet of *Fagus ferruginea* Michx. It is only proportionally a little shorter and broader, and twice as large. Fig. 127 represents a specimen slightly open on one side at the point, with the angles more obtuse. It may be a different species or even belong to another genus. The fruit fig. 126 is indeed very large for the nut of a Beech; but Unger, in his Chloris Protogæa (pag. 101, tab. 27, fig. 1 to 4), has published *Fagus Deucalionis* with nuts as large as those of the Brandon species. It comes from the tertiary of Bohemia.

Genus *Apeibopsis* (Heer). (*Cucumites* Bowerbank.) Prof. Heer has referred this genus to the family of *Tiliaceæ*, comparing it to *Apeiba*. It is characterized as follows: Fruit capsular, five to sixteen-valvate, polyspermous; seeds small, sub-globose, biseriate in each cell. On the characters of these fruits, the author further remarks: (Flor. tert. Helv., vol. iii, p. 38) "Where the bark of the fruit is preserved, it is marked with elongated warts and the fruit was externally verrucose. Within, it was probably filled with a fleshy matter containing the seeds in small cavities. In one specimen, (fig. 20 of Bowerbank) the seeds are placed without order in the central mass; in another (ibid., figs. 11, 12, 21, 34,) they appear to be placed in rows along the suture. Probably the fruit was divided into as many cells as there are furrows marked on the surface; but the walls were very thin and lost within the fleshy mass."

This description and the remarks of Prof. Heer agree well enough with what I was enabled to see by cutting a few of our

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Brandon fruits, evidently referable to this genus, and by a microscopical examination of their internal structure. In the American species, the parietal follicle of the capsules appear thick and each one is distinct and separated from the other in its whole width, from the folding of it at the surface to the suture with the central axis, also pretty thick. There are thus internally six or seven loculi or carpels, separated by double walls. The seeds, very small indeed (less than one millimeter in diameter) and very numerous, fill the cells entirely and are apparently mixed with a fleshy or cellular matter. Those nearest to the placenta and of both sides of each cell appear placed in rows upon the whole width of the parietes, being there perpendicular to it, and more oval or a little longer than in the middle of the cells, where they are nearly globose. These seeds are enclosed in a yellowish somewhat pellucid envelope, easily separated from them and marked on its inner concave surface by regular black points (or papillæ?). The seeds appear also somewhat papillous or rugose, just like the outer surface of the fruit. The largest specimen of these fruits that I have seen is scarcely more than half an inch in diameter, nearly exactly globular, or a little elongated or oval. The surface is not regularly verrucose, but rather irregularly deeply rugose, marked by seven or eight furrows a little elevated on the borders, along the line of flexure of the parietal tissue. The extremities of the central axis are marked on both sides of the fruit by a small round scar, only a little larger at the point of attachment.

On the distribution of this remarkable genus, Prof. Heer says that it appears at first in the Eocene of England, and takes its greatest development in the lower Molasse of the Tertiary of Switzerland where four species have been found. It has also been found in the lower Miocene of Italy and also in Bohemia, and is then apparently lost. From this it would appear that as the Brandon deposit, where specimens of this genus are abundant, belongs apparently to the Upper Miocene, as will be seen presently, this genus has appeared later or persisted longer in America than in Europe. The size of our fruit, compared with that of the European Apeibopsis, (which have sometimes a diameter of two inches) shows that our species are diminutive. Although the general form of our specimens is somewhat alike, I think nevertheless that we have two species.

No. 8. *Apeibopsis Heeri*, sp. nov. (Fig. 131, 132, 133.) Fruit globular, deeply grooved or rugose, distinctly marked by seven furrowed costæ.

No. 9. *Apeibopsis Gaudini*, sp. nov. (Fig. 139 and 140.) Fruit smaller, oval, depressed on one side; costæ more numerous and less marked, surface nearly smooth.

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It is on specimens of this last species that my examination was made. They appear abundant at Brandon but I have seen only three specimens of the former.

No. 10. *Aristolochia Œningensis*, Heer. (Fig. 134.) Fruit capsular, oval, six-costate, smooth or obscurely transversally rugose.

I cannot see any difference between our American specimen and Heer's figure of this species, except perhaps that the surface of the specimen appears somewhat transversally rugose. This appearance may be due to the process of maceration. Prof. Hitchcock's figure in this Journal (loc. cit. 1853) is quite the same as that of Heer (tab. 100, fig. 11, C. 1856), from a specimen of Œningen.

No. 11. *Aristolochia curvata*, sp. nov. (Fig. 135 and 136.) Fruit capsular, small, half an inch long, oval, pointed, marked with eight strong costæ, somewhat curved on one side.

No. 12. *Aristolochia obscura*, sp. nov. (Fig. 137, 138, and 141). Fruit capsular, small, one third of an inch in diameter, six or seven-costate, globular or a little flattened.

This species is uncertain. The specimens are not well preserved and I had not any for anatomical examination. I believe nevertheless that it is a specimen of this kind that Prof. Bailey has critically examined by a cross section. He found it a *six-valved pod, with seeds apparently flattened.* This agrees with the structure of the fruit of *Aristolochia.*

No. 13. *Sapindus Americanus*, sp. nov. (Fig. 142, 143, 144, 145.) Fruit oval-reniform, either smooth or irregularly rugose, depressed or flattened on one side, about half an inch in its greatest diameter.

These fruits have the general form of the fruit of *Cocculus Indicus* or of some fossil species of *Pavia.* They are smaller than the fruits of *Pavia* and moreover the cross section of one of the specimens (fig. 144) shows a fleshy cotyledonous substance enclosed in a thick putamen. The fruits also bear a marked round scar, showing a point of attachment at the upper end. It is not marked in the figure. These characters agree well enough with those of *Sapindus.* The nearest fossil species to that of No. 13 is *Sapindus lignitum* Ung., (l. c. pl. 1, page 33, tab. 6, fig. 3 to 5) from the lignites of Wetterau.

No. 14. *Carpolithes bursæformis*, sp. nov. (Fig. 146 and 147.) Fruit obovate, narrowed at one end, where it bears a round small cavity, inflated and obtuse at the other end, a little curved on one side, smooth.

I do not know of any fossil species to which this could be related. It is pear-shaped, as Prof. Hitchcock describes it; but it is a little curved on one side, a character that separates it from *Laurus.* As the specimens are much broken, this curved appearance may result from maceration, and if so, the species would

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well agree with *Laurus princeps* Heer, (l. c. vol. ii, page 77, tab. 89, fig. 176) from the upper tertiary of Europe, especially abundant at Œningen.

No. 15. *Cinnamomum Novæ-Angliæ*, sp. nov. (Fig. 148.) Fruit small, one sixth of an inch in diameter, globular, enlarged above, narrowed below to an obscurely costate point, apparently a broken pedicel, smooth.

I could not discover on the specimen the horizontal striæ marked on the figure. The fruit resembles that of a *Cinnamomum*, a genus well represented in the different stages of the tertiary of Europe. Of nine species described by Prof. Heer, five are found at Œningen. This genus as it is established by the same author is also represented in the Tertiary of America. Among a small number of fossil leaves collected by Dr. J. Evans in the Tertiary of Vancouver, there are specimens of two fine species of leaves of *Cinnamomum*. One other is abundant in the strata of the Tertiary of Mississippi (State).

No. 16. *Illicium lignitum*, sp. nov. (Fig. 149.) Seed small, one eighth of an inch long, oval, pointed, marked at the point by a small scar and by a ring on one side, very smooth and shining.

I can not but refer this seed to *Illicium*. It is a little thicker and more pointed than that of *Illicium anisatum* of China; but about the same size and the same form. Two species of *Illicium* are still living in the southern part of the United States (Gray's genera, vol. i, pag. 56.) On comparison with the published species of fossil plants, our seed is like the one figured by Göppert, under the general name of Drupa (Flora of Shossnitz, tab. 26, fig. 34). The tertiary of Shossnitz is of the same age as that of Œningen (Heer, vol. iii, pag. 306).

No. 17. *Drupa rhabdosperma*, sp. nov.? (Fig. 150.) Seed small, about of the same size and of the same form as the former, oval, pointed, or slightly beaked, finely and deeply striated, marked under the point by a deep triangular scar.

These seeds resemble those of *Pinus rhabdosperma* Heer, (vol. i, pag. 60, tab. 21, fig. 14) from the Miocene of Switzerland. The likeness is not enough to prove that our seeds are of the same species, or even of the same genus. Analogous forms of such small ribbed seeds are found in different genera. The putamen is pretty thick, very hard, bony, and in all the specimens that I have broken the kernel has been destroyed or the seed is empty. The kernel is covered with a brownish skin, like that enveloping the albumen of the seeds of the Pines. However the affinity of these seeds with those of a Pine is rendered doubtful by the absence of every trace of a wing in all the specimens, six in number, that I have seen.

No. 18. *Carpinus grandis?* Heer (l. c., vol. ii, pag. 40, tab. 72, fig. 15.) Nutlet oval, about one eighth of an inch in length, ribbed or striated.

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I have not seen any specimen of this species. Prof. Hitchcock's figure 151 is like that of Prof. Heer for this species. *Carpinus Grandis* Heer, is from the upper Miocene of Switzerland.

No. 19. *Leguminosites pisiformis?* Heer (l. c., vol. iii, p. 129, tab. 133, fig. 37 to 40.) Seed globose, perfectly smooth, shining, one sixth of an inch broad.

Round small seeds like this are found in great number in the Tertiary of Europe and have been described under various names. The *Drupæ* (fig. 29 and 30 of tab. 26) of Göppert's flora of Shossnitz; the seeds of *Menianthes tertiaria* Heer (l. cit., vol. iii, pag. 20, tab. 104, fig. 20); some species of *Podogonium; Podogonium Knorrii* Heer (vol. iii, pag. 114, tab. 135), a characteristical plant of the upper Miocene of Europe, especially abundant at Œningen; and a number of *Carpolithes* or undetermined seeds. Though the identity of our Brandon *Leguminosites* with that of Œningen, (*L. pisiformis*) is far from certain, it is however remarkable that most of those fossil seeds that have about the same form as ours belong to the upper Tertiary.

No. 20. *Nyssa complanata*, sp. nov. (Fig. 153.) Fruit oval, a little flattened, bicostate with a deep furrow in the middle.

This species particularly resembles *Nyssa Vertumni* Ung., (Sill., pl. p. 16, tab. 8, fig. 19 and 20) from the lignites of the Rhine.

No. 21. *Nyssa microcarpa*, sp. nov. (Fig. 154.) Fruit oval, scarcely compressed, regularly ribbed, short.

Fig. 155 is longer; the point of the specimen is obliquely broken and thus its form can not be seen. It is perhaps some other species of the same genus. Our No. 21 is related to *Nyssa ornithobroma* Ung., (loc. cit., p. 16, tab. 8, fig. 15 and 18,) a species also from the lignites of Vetteravia.

No. 22. *Nyssa lævigata*, sp. nov. (Fig. 156.) Fruit cylindrical-oval, obtuse at one end, abruptly cut at the other, smooth.

The position of these fruits, as they are figured and their form, recall immediately the general appearance of the fruits of *Nyssa multiflora*. The likeness is still greater in comparing dry drupes of this species with the fossil specimens. The thick putamen of some *Nyssæ* is well adapted for preservation in the lignites. Though our fossil species is related to the living *Nyssa multiflora*, it differs by the size of the nutlets and the absence of striæ.

No. 23. *Carpolithes venosus?* Sternberg (Vers., vol. ii, pag. 208, tab. 58, fig. 18 to 20.) Fruit oval, about one inch long, irregularly and deeply sulcate and veined (fig. 157 to 160).

This is apparently a *Carya*. But the likeness with the species published by Sternberg, under the above name, is too great to permit a separation. Some pieces of the putamen, figured 159 and 160, have about the same thickness as that of *Carya olivæformis*, and are marked on the inner surface by irregularly crossed

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wrinkles like those of the *Carya*. This *Carpolithes venosus* is a species of the lignites of Bohemia.

To close this examination, I have still to mention a piece of the wood found in the lignites of Brandon. This wood, somewhat hardened and blackened, is still in a good state of preservation. It is soft enough to be cut with a knife, or at least easily broken, and on a section, it shows evidently the character of a Dicotyledonous wood. It cannot be specifically determined, of course; but it looks like the wood of a *Juglans* or a *Carya*.

Before I had had an opportunity of examining the fossil fruits of Brandon, and judging only from the drawings and descriptions published by Prof. Hitchcock (l. c.) I had, in a letter to Prof. J. D. Dana, given the opinion that the Brandon lignites were of the same age as the upper Tertiary deposits of Œningen. This opinion is fully confirmed by all that has been said above of the relation of those fruits with species of Œningen. It is true that the identity of species is not ascertained; but this, of course, can not be expected; and it is enough that the greatest number of the Brandon species are more generally related to species of Œningen, than to species of any other stage of the Tertiary, to authorize the above conclusion and to render it credible.

It is to be regretted that the fossil flora of the Tertiary of Mississippi is not better known. I have indeed found below Columbus, Ky., some specimens of fruits of a *Carpinus* and of a *Carya*, this last referable to *Carya olivæformis*, in the chalk banks, overlaid by ferruginous conglomerate. And in some red shales, received from Mississippi, I have found the fruit of a *Fagus*, resembling *Fagus ferruginéa* if not identical with it. These data are too scanty to afford a point of comparison. But judging from the position of the lignites of Brandon, or rather from the nature of the strata overlying it, as it is described in Prof. Hitchcock's paper, I must believe that they are of the same age as the upper lignite formation that extends on both sides of the Mississippi, and which I had opportunity to explore in Arkansas, in company with my friend Prof. E. T. Cox. His general section of the Tertiary of Dallas county, Arkansas, presents in an exact manner a resumée of a number of local sections of that country. It is given in detail in the Geological Report of Arkansas by Dr. D. Dale Owen (vol. ii, p. 410) thus:—

General Section of the Tertiary of Dallas county, Arkansas.

Waterworn pebbles and gravel cemented by ferruginous conglomerate.

Place of fossil, generally silicified wood.

Red sandy clay, sometimes containing good iron ore and ferruginous sandstone, the last much fluted.

Light colored sand.

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Upper lignite bed.
Ash-colored sandy clay.
Plastic potter clay.
Lower lignite.

The Copperas bluffs in St. Francis county, Ark., (same report, p. 418) show a section much like the above. A number of sections of the Geological report of Mississippi, by Dr. Eug. W. Hilgard, especially that of page 118, may be compared also with those of the strata accompanying the lignite deposit of Vermont. All show the same characters, viz., lignitic strata overlaid at some distance by strata of iron-ore or deposits of various kinds charged with iron. I know that it is still a question if all these lignite strata of the Mississippi shores, which I consider as upper tertiary, belong to the same age. Palæontology only can decide, when sufficient materials are collected. I will only remark that the lignites of Lauderdale, Miss., presenting with their accompanying strata a section resembling the above, are placed by Dr. Hilgard near the base of the tertiary, while their fossil plants show the greatest affinity with species of our time and are apparently of as recent an epoch as the fruits of Brandon, Vt.

Columbus, Ohio, Sept. 12, 1861.

ART. XL.—*Thirty-First Congress of the British Association for the Advancement of Science—with extracts from the Address of Mr. Fairbairn at the opening.*

THIS Congress assembled at Manchester on the 5th of September, and appears to have exceeded all others before held in the numbers present—in the amount of general and local subscriptions, (upon which the efficiency of the Association in promoting investigations mainly depends) in the value and number of the papers read, in the interest of the personal discussion, and in the excellence and variety of the evening discourses. Among the lectures we remark as of special interest the Astronomer Royal's (Airy) discourse on the eclipse of the sun; and Prof. Miller's lecture on the Spectrum Analysis.

The two subjects which commanded most general attention among those brought forward, were the Origin of Man, and Iron Plated Ships. The observations of Prof. Owen we shall publish as soon as they are received—those of Mr. Fairbairn we quote from his address.

The next meeting of the Association is to be held at Cambridge, when etiquette will probably require His Royal Highness the Prince of Wales to take the chair, who with such Vice Presidents as Dr. Whewell, Prof. Airy and Prof. Sedgwick will doubtless do honor to the Royal prerogative.

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The sums recommended for special researches the coming year amounted to 2,368*l.* against 1,395*l.* last year. An Index to the Reports is in course of preparation, for which we observe an appropriation of 600*l.*

We copy from the London Athenæum the following extracts from:—

The Address of the President.

"*Gentlemen of the British Association*,—Ever since my election to the high office I now occupy I have been deeply sensible of my own unfitness for a post of so much distinction and responsibility; and when I call to mind the illustrious men who have preceded me in this chair, and see around me so many persons much better qualified for the office than myself, I feel the novelty of my position and unfeigned embarrassment in addressing you. I should however, very imperfectly discharge the duties which devolve upon me, as the successor of the distinguished nobleman who presided over the meetings of last year, if I neglected to thank you for the honorable position in which you have placed me, and to express at the outset my gratitude to those valued friends with whom I have been united for many years in the labors of the Sections of this Association, and from whom I have invariably received every mark of esteem."

"A careful perusal of the history of this Association will demonstrate that it was the first, and for a long time the only institution which brought together for a common object the learned Professors of our Universities and the workers in practical science. These periodical *réunions* have been of incalculable benefit in giving to practice that soundness of principle and certainty of progressive improvement which can only be obtained by the accurate study of science and its application to the arts. On the other hand, the men of actual practice have reciprocated the benefits thus received from theory, in testing by actual experiment deductions which were doubtful and rectifying those which were erroneous. Guided by an extended experience, and exercising a sound and disciplined judgment, they have often corrected theories apparently accurate, but nevertheless founded on incomplete data or on false assumptions inadvertently introduced. If the British Association had effected nothing more than the removal of anomalous separation of theory and practice, it would have gained imperishable renown in the benefit thus conferred. Were I to enlarge on the relation of the achievements of science to the comforts and enjoyments of man, I should have to refer to the present epoch as one of the most important in the history of the world. At no former period did science contribute so much to the uses of life and the wants of society. And in doing this it has only been fulfilling that mission which Bacon, the great father of modern science, appointed for it, when he wrote that "the legimate goal of the sciences is the endowment of human life with new inventions and riches," and when he sought for a natural philosophy which, not spending its energy on barren disquisitions, "should be operative for the benefit and endowment of mankind." Looking, then, to the fact that, while in our time all the sciences have yielded this fruit, engineering science, with which I have been most intimately connected, has preëmminently advanced the power, the wealth, and the comforts of man-

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kind, I shall probably best discharge the duties of the office I have the honor to fill by stating, as briefly as possible, the more recent scientific discoveries which have so influenced the relations of social life. I shall, therefore, not dwell so much on the progress of abstract science, important as that is, but shall rather endeavor briefly to examine the applications of science to the useful arts, and the results which have followed, and are likely to follow, in the improvement of the condition of society." * * *

"In attempting to notice those branches of science with which I am but imperfectly acquainted, I shall have to claim your indulgence. This Association, as you are aware, does not confine its discussions and investigations to any particular science; and one great advantage of this is, that it leads to the division of labor, while the attention each department receives, and the harmony with which the plan has hitherto worked, afford the best guarantee of its wisdom and proof of its success." * * *

* * "Our knowledge of the physical constitution of the central body of our system seems likely, at the present time, to be much increased. The spots on the sun's disc were noticed by Galileo and his contemporaries, and enabled them to ascertain the time of its rotation and the inclination of its axis. They also correctly inferred, from their appearance, the existence of a luminous envelope, in which funnel-shaped depressions revealed a solid and dark nucleus. Just a century ago, Alexander Wilson indicated the presence of a second and less luminous envelope beneath the outer stratum; and his discovery was confirmed by Sir William Herschel, who was led to assume the presence of a double stratum of clouds, the upper intensely luminous, the lower grey, and forming the penumbra of the spots. Observations during eclipses have rendered probable the supposition that a third and outermost stratum of imperfect transparency incloses concentrically the other envelopes. Still more recently, the remarkable discoveries of Kirchoff and Bunsen require us to believe that a solid or liquid photosphere is seen through an atmosphere containing iron, sodium, lithium, and other metals in a vaporous condition. We must still wait for the application of more perfect instruments, and especially for the careful registering of the appearances of the sun by the photoheliograph of Sir John Herschel, so ably employed by Mr. Warren De La Rue, Mr. Welsh, and others, before we can expect a solution of all the problems thus suggested.

"Guided by the same principles which have been so successful in astronomy, its sister science, Magnetism, emerging from its infancy, has of late advanced rapidly in that stage of development which is marked by assiduous and systematic observation of the phenomena, by careful analysis and presentation of the facts which they disclose, and by the grouping of these in generalizations, which, when the basis on which they rest shall be more extended, will prepare the way for the conception of a general physical theory, in which all the phenomena shall be comprehended, while each shall receive its separate and satisfactory explanation. It is unnecessary to remind you of the deep interest which the British Association has at all times taken in the advancement of this branch of natural knowledge, or of the specific recommendations which, made in conjunction with the Royal Society, have been productive of such various and important results. To refer but to a single instance: we

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have seen those magnetic disturbances, so mysterious in their origin and so extensive in simultaneous prevalence,—and which, less than twenty years ago, were designated by a term specially denoting that their laws were wholly unknown,—traced to laws of periodical recurrence, revealing, without a doubt, their origin in the central body of our system, by inequalities which have for their respective periods the solar day, the solar year, and, still more remarkably, and until lately unsuspected, solar cycle of about ten of our terrestrial years, to whose existence they bear testimony in conjunction with the solar spots; but whose nature and causes are in all other respects still wrapped in entire obscurity. We owe to General Sabine, especially, the recognition and study of these and other solar magnetic influences, and of the magnetic influence of the moon similarly attested by concurrent determinations in many parts of the globe, which are now held to constitute a distinct branch of this science, not inappropriately named "celestial," as distinguished from purely terrestrial magnetism."

"We ought not in this town to forget that the very rapid advance which has been made in our time in Chemistry is due to the law of equivalents, or Atomic Theory, first discovered by our townsman, John Dalton. Since the development of this law, its progress has been unimpeded, and it has had a most direct bearing on the comforts and enjoyments of life." * * *

"The largest developments of chemistry, however, have been in connexion with the useful arts. What would now be the condition of calico-printing, bleaching, dyeing, and even agriculture itself, if they had been deprived of the aid of theoretic chemistry? For example, aniline—first discovered in coal tar by Dr. Hoffman, who has so admirably developed its properties—is now most extensively used as the basis of red, blue, violet, and green dyes. This important discovery will probably in a few years render this country independent of the world for dye stuffs; and it is more than probable that England, instead of drawing her dye stuffs from foreign countries, may herself become the centre from which all the world will be supplied. It is an interesting fact that at the same time, in another branch of this science, M. Tournet has lately demonstrated that the colors of gems, such as the emerald, aqua-marina, amethyst, smoked rock-crystal, and others, are due to volatile hydro-carbons, first noticed by Sir David Brewster in clouded topaz, and that they are not derived from metallic oxyds, as has been hitherto believed. Another remarkable advance has recently been made by Bunsen and Kirchoff in the application of the colored rays of the prism to analytical research. We may consider their discoveries as the commencement of a new era in analytical chemistry, from the extraordinary facilities they afford in the qualitative detection of the minutest traces of elementary bodies. The value of this method has been proved by the discovery of the new metals, *cæsium* and *rubidium*, by M. Bunsen; and it has yielded another remarkable result in demonstrating the existence of iron and six other known metals in the sun. In noticing the more recent discoveries in this important science I must not pass over in silence the valuable light which chemistry has thrown upon the composition of iron and steel. Although Despretz demonstrated many years ago that iron would combine with nitrogen, yet it was not until 1857 that Mr. C. Binks proved that nitrogen is an essential element of steel; and more recently M. Caron and M. Frémy have further eluci-

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dated this subject; the former showing that cyanogen, or cyanid of ammonium, is the essential element which converts wrought iron into steel; the latter combining iron with nitrogen through the medium of ammonia, and then converting it into steel by bringing it at the proper temperature into contact with common coal gas. There is little doubt that in a few years these discoveries will enable Sheffield manufacturers to replace their present uncertain, cumbrous, and expensive process by a method at once simple and inexpensive, and so completely under control as to admit of any required degree of conversion being obtained with absolute certainty. Mr. Crace Calvert, also, has proved that cast iron contains nitrogen, and has shown that it is a definite compound of carbon and iron, mixed with various proportions of metallic iron, according to its nature. Before leaving chemical science, I must refer to the interesting discovery by M. Deville, by which he succeeded in rapidly melting thirty-eight or forty pounds of platinum—a metal till then considered almost infusible. This discovery will render the extraction of platinum from the ore more perfect, and, by reducing its cost, will greatly facilitate its application to the arts."

"It is litttle more than half a century since geology assumed the distinctive character of a science. Taking into consideration the aspects of nature in different epochs of the history of the earth, it has been found that the study of the changes at present going on in the world around us enables us to understand the past revolutions of the globe, and the conditions and circumstances under which strata have been formed and organic remains embedded and preserved. The geologist has increasingly tended to believe that the changes which have taken place on the face of the globe, from the earliest times to the present, are the result of agencies still at work. But while it is his high office to record the distribution of life in past ages, and the evidence of physical changes in the arrangement of land and water, his results hitherto have indicated no traces of its beginning, nor have they afforded evidence of the time of its future duration. Geology has been indebted for this progress very largely to the investigations of Sedgwick and the writings of Sir Charles Lyell." * *

"It is well known that the temperature increases as we descend through the earth's crust, from a certain point near the surface, at which the temperature is constant. In various mines, borings, and artesian wells the temperature has been found to increase about one degree Fahrenheit for every sixty or sixty-five feet of descent. In some carefully conducted experiments during the sinking of Dukinfield Deep Mine—one of the deepest pits in this country—it was found that a mean increase of about one degree in seventy-one feet occurred. If we take the ratio thus indicated, and assume it to extend to much greater depths, we should reach at two and a half miles from the surface strata at the temperature of boiling water; and at depths of about fifty or sixty miles the temperature would be sufficient to melt, under the ordinary pressure of the atmosphere, the hardest rocks. Reasoning from these facts, it would appear that the mass of the globe, at no great depth, must be in a fluid state. But this deduction requires to be modified by other considerations, namely, the influence of pressure on the fusing point, and the relative conductivity of the rocks which form the earth's crust. To solve these questions a series

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of important experiments were instituted by Mr. Hopkins, in the prosecution of which Dr. Joule and myself took part; and after a long and laborious investigation it was found that the temperature of fluidity increased about one degree Fahrenheit for every five hundred pounds of pressure in the case of spermaceti, beeswax, and other similar substances. However, on extending these experiments to less compressible substances, such as tin and barytes, a similar increase was not observed. But this series of experiments has been unavoidably interrupted; nor is the series on the conductivity of rocks entirely finished. Until they have been completed by Mr. Hopkins, we can only make a partial use of them in forming an opinion of the thickness of the earth's solid crust. Judging, however, alone from the greater conductivity of the igneous rocks, we may calculate that the thickness cannot possibly be less than nearly three times as great as that calculated on the usual suppositions of the conductive power of the terrestrial mass at enormous depths being no greater than that of the superficial sedimentary beds. Other modes of investigation which Mr. Hopkins has brought to bear on this question appear to lead to the conclusion that the thickness of the earth's crust is much greater even than that above stated. This would require us to assume that a part of the heat in the crust is due to superficial and external rather than central causes. This does not bear directly against the doctrine of central heat, but shows that only a part of the increase of temperature observed in mines and deep wells is due to the outward flow of that heat." * * *

"Two other branches of scientific research, Geography and Ethnology, have for some years been united, in this Association, in one Section, and that probably the most attractive and popular of them all. We are much indebted to Sir Roderick Murchison, among other members of the Association, for its continued prosperity, and the high position it has attained in public estimation. The spirit of enterprise, courage and perseverance displayed by our travellers in all parts of the world have been powerfully stimulated and well supported by the Royal Geographical Society; and the prominence and rapid publicity given to discoveries by that body have largely promoted geographical research. In Physical Geography, the late Baron von Humboldt has been one of the largest contributors, and we are chiefly indebted to his personal researches and numerous writings for the elevated position it now holds among the sciences. To Humboldt we owe our knowledge of the physical features of Central and Southern America. To Parry, Sir James Ross and Scoresby we are indebted for discoveries in the Arctic and Antarctic regions. Geography has also been advanced by the first voyage of Franklin down the Copper Mine River, and along the inhospitable shores of the Northern seas, as far as Point Turnagain; as also by that ill-fated expedition in search of a northwest passage, followed by others in search of the unfortunate men who perished in their attempt to reach those ice-bound regions, so often stimulated by the untiring energy of a high-minded woman. In addition to these, the discoveries of Dr. Livingstone in Africa have opened to us a wide field of future enterprise along the banks of the Zambesi and its tributaries. To these, we may add the explorations of Capt. Burton in the same continent, and those also by Capt. Speke and Capt. Grant of

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a hitherto unknown region, in which it has been suggested that the White Nile has its source, flowing from one of two immense lakes, upwards of 300 miles long by 100 broad, and situated at an elevation of 4,000 feet above the sea. To these remarkable discoveries I ought to add an honorable mention of the sagacious and perilous exploration of Central and Northern Australia by Mr. M'Douall Stuart.

Having glanced, however imperfectly, at some of the most important branches of science which engage the attention of Members of this Association, I would now invite attention to the Mechanical Sciences, with which I am more familiarly acquainted. They may be divided into Theoretical Mechanics and Dynamics, comprising the conditions of equilibrium and the laws of motion; and Applied Mechanics, relating to the construction of machines. I have already observed that Practice and Theory are twin sisters, and must work together to insure a steady progress in mechanical art. Let us, then, maintain this union as the best and safest basis of national progress, and, moreover, let us recognize it as one of the distinctive aims of the annual *réunions* of this Association. During the last century, the science of Applied Mechanics has made strides which astonish by their magnitude; but even these, it may reasonably be hoped, are but the promise of future and more wonderful enlargements. I therefore propose to offer a succinct history of these improvements, as an instance of the influence of scientific progress on the well-being of society. I shall take in review the three chief aids which engineering science has afforded to national progress,—namely, canals, steam navigation and railways; each of which has promoted an incalculable extension of the industrial resources of the country. One hundred years ago, the only means for the conveyance of inland merchandise were the packhorses and wagons on the then imperfect highways. It was reserved for Brindley, Smeaton and others to introduce a system of canals, which opened up facilities for an interchange of commodities at a cheap rate over almost every part of the country. The impetus given to industrial operations by this new system of conveyance induced capitalists to embark in trade, in mining, and in the extension of manufactures in almost every district. These improvements continued for a series of years, until the whole country was intersected by canals, requisite to meet the demands of a greatly extended industry. But canals, however well adapted for the transport of minerals and merchandise, were less suited for the conveyance of passengers. The speed of the canal boats seldom exceed from 2½ to 3 miles an hour; and, in addition to this, the projectors of canals sometimes sought to take an unfair advantage of the Act of Parliament, which fixed the tariff at so much per ton per mile, by adopting circuitous routes, under the erroneous impression that mileage was a consideration of great importance in the success of such undertakings. It is in consequence of short-sighted views and imperfect legislation that we inherit the numerous curves and distortions of our canal system." * *

"Scarcely had the canal system been fully developed when a new means of propulsion was adopted—namely, steam. I need not recount to you the enterprise, skill and labor that have been exerted in connection with steam navigation. You have seen its results on every river and sea; results we owe to the fruitful minds of Miller, Symington, Fulton,

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and Henry Bell, who were the pioneers in the great march of progress. Viewing the past, with a knowledge of the present and a prospect of the future, it is difficult to estimate sufficiently the benefits that have been conferred by this application of mechanical science to the purposes of navigation. Power, speed, and certainty of action have been attained on the most gigantic scale. The celerity with which a modern steamer, with a thousand tons of merchandise and some hundreds of human beings on board, cleaves the water and pursues her course far surpasses the most sanguine expectations of a quarter of a century ago, and indeed almost rivals the speed of the locomotive itself. Previous to 1812 our intercourse with foreign countries and with our colonial possessions depended entirely upon the state of the weather. It was only in favorable seasons that a passage was open, and we had often to wait days, or even a week, before Dublin could be reached from Holyhead. Now this distance of sixty-three miles is accomplished in all weathers in little more than three hours. The passage to America used to occupy six weeks, or two months; now it is accomplished in eight or nine days. The passage round the Cape to India is reduced from nearly half a year to less than a third of that time, while that country may be reached by the overland route in less than a month.

"These are a few of the benefits derived from steam navigation, and, as it is yet far from perfect, we may reasonably calculate on still greater advantages in our intercourse with distant nations. I will not here enter on the subject of the numerous improvements which have so rapidly advanced the progress of this important service. Suffice it to observe that the paddle-wheel system of propulsion has maintained its superiority over every other method yet adopted for the attainment of speed, as by it the best results are obtained with the least expenditure of power. In ships of war the screw is indispensable, on account of the security it affords to the engines and machinery, from their position in the hold below the water line, and because of the facility it offers in the use of sails, when the screw is raised from its position in the well to a recess in the stern prepared for that purpose. It is also preferable in ships which require auxiliary power in calms and adverse winds, so as to expedite the voyage and affect a considerable saving upon the freight.

"The public mind had scarcely recovered itself from the changes which steam navigation had caused, and the impulse it had given to commerce, when a new and more gigantic power of locomotion was inaugurated. Less than a quarter of a century had elapsed since the first steamboats floated on the waters of the Hudson and the Clyde, when the achievements thence resulting were followed by the application of the same agency to the almost superhuman flight of the locomotive and its attendant train. I well remember the competition at Rainhill in 1830, and the incredulity everywhere evinced at the proposal to run locomotives at 20 miles an hour. Neither George Stephenson himself, nor any one else had at that time the most distant idea of the capabilities of the railway system. On the contrary, it was generally considered impossible to exceed 10 or 12 miles an hour; and our present high velocities, due to high-pressure steam and the tubular system of boilers, have surpassed the most sanguine expectations of engineers. The sagacity of George Stephenson at

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once seized upon the suggestions of Henry Booth, to employ tubular boilers; and, that, united to the blast-pipe, previously known, has been the means of affecting all the wonders we now witness in a system that has done more for the development of practical science and the civilization of man than any discovery since the days of Adam." * * *

Want of space compels us to pass Mr. Fairbairn's very interesting remarks on the history of the steam engine and the manufacturing industry of Great Britain.

"I might greatly extend this description of our manufacturing industry, but I must for the present be brief, in order to point out the dependence of all these improvements on the iron and coal so widely distributed among the mineral treasures of our island. We are highly favored in the abundance of these minerals, deposited with an unsparing hand by the great Author of Nature, under so slight a covering as to bring them within reach of the miner's art. To them we owe our present high state of perfection in the useful arts; and to their extended application we may safely attribute our national progress and wealth. So that, looking to the many blessings which we daily and hourly receive from these sources alone, we are impressed with devotional feelings of gratitude to the Almighty for the manifold bounties He has bestowed on us. Previously to the inventions of Henry Cort, the manufacture of wrought iron was of the most crude and primitive description. A hearth and a pair of bellows was all that was employed. But since the introduction of puddling, the iron-masters have increased the production to an extraordinary extent, down to the present time, when processes for the direct conversion of wrought iron on a large scale are being attempted. A consecutive series of chemical researches into the different processes, from the calcining of the ore, to the production of the bar, carried on by Dr. Percy and others, has led to a revolution in the manuafcture of iron; and although it is at the present moment in a state of transition, it nevertheless requires no very great discernment to perceive that steel and iron of any required tenacity will be made in the same furnace, with a facility and certainty never before attained. This has been effected to some extent by improvements in puddling; but the process of Mr. Bessemer—first made known at the meeting of this Association in Cheltenham—affords the highest promise of certainty and perfection in the operation of converting the melted pig direct into steel or iron, and is likely to lead to the most important developments in this manufacture. These improvements in the production of the material must, in their turn, stimulate its application on a larger scale and lead to new constructions.

In iron shipbuilding an immense field is opening before us. Our wooden walls have to all appearances seen their last days; and as one of the early pioneers in iron construction, as applied to shipbuilding, I am highly gratified to witness a change of opinion that augurs well for the securities of the liberties of the country. From the commencement of iron shipbuilding in 1830 to the present time, there could be only one opinion among those best acquainted with the subject, namely, that iron must eventually supersede timber in every form of naval construction. The large ocean steamers, the Himalaya, the Persia, and the Great East-

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ern, abundantly show what can be done with iron, and we have only to look at the new system of casing ships with armor plates, to be convinced that we can no longer build wooden vessels of war with saftey to our naval superiority and the best interests of the country. I give no opinion as to the details of the reconstruction of the navy—that is reserved for another place—but I may state that I am fully persuaded that the whole of our ships of war must be rebuilt of iron, and defended with iron armor calculated to resist projectiles of the heaviest description at high velocities. In the early stages of iron shipbuilding, I believe I was the first to show, by a long series of experiments, the superiority of wrought iron over every other description of material in security and strength, when judicially applied in the construction of ships of every class. Other considerations, however, affect the question of vessels of war; and although numerous experiments were made, yet none of the targets were on a scale sufficient to resist more than a 6-pounder shot. It was reserved for our scientific neighbors, the French, to introduce thick iron plates as a defensive armor for ships. The success which has attended the adoption of this new system of defence affords the prospect of invulnerable ships of war, and hence the desire of the government to remodel the Navy on an entirely new principle of construction, in order that we may retain its superiority as the great bulwark of the nation. A committee has been appointed by the war-office and the admiralty for the purpose of carrying out a scientific investigation of the subject, so as to determine, first, the best description of material to resist projectiles; secondly, the best method of fastening and applying that material to the sides of ships and land fortifications; and, lastly, the thickness necessary to resist the different descriptions of ordnance.

"It is asserted, probably with truth, that whatever thickness of plates is adopted for casing ships, guns will be constructed capable of destroying them. But their destruction will even then be a work of time, and I believe, from what I have seen in recent experiments, that with proper armor it would require, not only the most powerful ordnance, but also a great concentration of fire, before fracture will ensue. If this be the case, a well-constructed iron ship, covered with sound plates of the proper thickness, firmly attached to its sides, will, for a considerable time, resist the heaviest guns which can be brought to bear against it, and be practically shot-proof. But our present means are inadequate for the production of large masses of iron, and we may trust that, with new tools and machinery, and the skill, energy, and perseverance of our manufacturers, every difficulty will be overcome, and armor plates produced which will resist the heaviest existing ordnance. The rifling of heavy ordnance, the introduction of wrought iron, and the new principle of construction with strained hoops, have given to all countries the means of increasing enormously the destructive power of their ordnance. One of the results of this introduction of wrought iron and correct principles of manufacture, is the reduction of the weight of the new guns to about two-thirds the weight of the older cast-iron ordnance. Hence follows the facility with which guns of much greater power can be worked, while the range and precision are at the same time increased. But these improvements cannot be confined to ourselves. Other nations are increasing the power and

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range of their artillery in a similar degree, and the energies of the nation must, therefore, be directed to maintain the superiority of our navy in armor as well as in armament." * * *

"Among the changes which have large contributed to the comfort and enjoyment of life, are the improvements in the sanitary condition of towns. These belong probably to the province of social rather than mechanical science; but I cannot omit to notice some of the great works that have of late years been constructed for the supply of water and for the drainage of towns. In former days 10 gallons of water to each person per day was considered an ample allowance. Now, 30 gallons is much nearer the rate of consumption. I may instance the water-works of this city and of Liverpool, each of which yield a supply of from 20 to 30 gallons of water to each inhabitant. In the former case the water is collected from the Cheshire and Derbyshire hills, and after being conveyed in tunnels and aqueducts a distance of 10 miles to a reservoir, where it is strained and purified, it is ultimately taken a further distance of eight miles in pipes, in a perfectly pure state, ready for distribution. The greatest undertaking of this kind, however, yet accomplished is that by which the pure waters of Loch Katrine are distributed to the city of Glasgow. This work, recently completed by Mr. Bateman, who was also the constructor of the water works of this city, is of the most gigantic character, the water being conveyed in a covered tunnel a distance of 27 miles through an almost impassable country to the service reservoir, about eight miles from Glasgow. By this means 40 million gallons of water per day are conveyed through the hills which flank Ben Lomond, and after traversing the sides of Loch Chon and Loch Aird, are finally discharged into the Mudgdock Basin, where the water is impounded for distribution. We may reasonably look forward to an extension of similar benefits to the metropolis, by the same Engineer, whose energies are now directed to an examination of the pure fountain of Wales, from whence the future supply of water to the great city is likely to be derived. A work of so gigantic a character may be looked upon as problematical, but when it is known that six or seven millions of money would be sufficient for its execution, I can see no reason why an undertaking of so much consequence to the health of London should not ultimately be accomplished." * * *

"A brief allusion must be made to that marvellous discovery which has given the present generation the power to turn the spark of heaven to the uses of speech; to transmit along the slender wire for a thousand miles a current of electricity that renders intelligible words and thoughts. This wonderful discovery, so familiar to us, and so useful in our communications to every part of the globe, we owe to Wheatstone, Thompson, De la Rive, and others. In land telegraphy the chief difficulties have been surmounted, but in submarine telegraphy much remains to be accomplished. Failures have been repeated so often as to call for a commission on the part of Government to inquire into the causes, and the best means of overcoming the difficulties which present themselves. I had the honor to serve on that commission, and I believe that from the report, and mass of evidence and experimental research accumulated, the public will derive very important information. It is well known that three conditions are

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essential to success in the construction of ocean telegraphs—perfect insulation, external protection, and appropriate apparatus for laying the cable safely on its ocean bed. That we are far from having succeeded in fulfilling these conditions is evident from the fact that out of 12,000 miles of submarine cable which have been laid since 1851, only 3,000 miles are in actual working order; so that three-fourths may be considered as a failure and loss to the country. The insulators hitherto employed are subject to deterioration from mechanical violence, from chemical decomposition or decay, and from the absorption of water; but the last circumstance does not appear to influence seriously the durability of cables. Electrically, india-rubber possesses high advantages, and, next to it, Wray's compound and pure gutta percha far surpass the commercial gutta percha hitherto employed; but it remains to be seen whether the mechanical and commercial difficulties in the employment of these new materials can be successfully overcome. The external projecting covering is still a subject of anxious consideration. The objections to iron wire are its weight and liability to corrosion. Hemp has been substituted, but at present with no satisfactory result. All these difficulties, together with those connected with the coiling and paying out of the cable, will no doubt yield to careful experiment and the employment of proper instruments in its construction, and its final deposit on the bed of the ocean. Irrespective of inland and international telegraphy, a new system of communication has been introduced by Prof. Wheatstone, whereby intercourse can be carried on between private families, public offices, and the works of merchants and manufacturers. This application of electric currents cannot be too highly appreciated, from its great efficiency and comparatively small expense. To show to what an extent this improvement has been carried, I may state that 1,000 wires in a perfect state of insulation, may be formed into a rope not exceeding half an inch in diameter." * *

ART. XLI.—*Note on a Compound of Ammonia, Mercury and Nitric Acid;* by M. CAREY LEA, Philadelphia.

IN the course of an extended examination upon the reactions of the ethyl bases, I noticed that both ethylamine and diethylamine gave with acid solution of mercuric nitrate a white precipitate which is permanent although the solution contains a large excess of acid. This compound did not appear worthy of a special examination as it is no doubt analogous to that formed by ammonia under similar circumstances. But with respect to the constitution of this latter I propose to offer a few remarks.

The formula adopted for this compound by L. Gmelin, apparently on the authority of Kane, C. G. Mitscherlich and Pagenstecher, whose analyses are quoted, is

$$HgNH_2 + 2HgO, NO_5.$$

This view of the constitution is liable to two objections; first, that it supposes the existence of the bibasic nitrate of mercury

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in it, which substance is so unstable that it is decomposed by mere contact with cold water; second, that it is unnecessarily complicated. If we assign to the compound the formula

$$\left.\begin{matrix}Hg_2\\H\end{matrix}\right\}NO, NO_5+2HO,$$

differing from the foregoing by 1 at. H and 1 at. O, we greatly simplify our view of its constitution, and refer it to the class of substituted ammonias.

Adopting this view, we are able to explain its formation by the action of ammonia on mercuric nitrate, by a very natural equation

$$3(HgONO_5)+NH_3=\underbrace{\left.\begin{matrix}Hg_2\\H\end{matrix}\right\}NO, NO_5+2HO+2NO_5}_{\text{new body}}$$

(unless ammonia be added in excess, the solution always remains strongly acid).

Not only is the formula here proposed more in harmony with the views entertained at the present day, which tend as far as possible to refer such compounds to the ammonia type, but, what is somewhat remarkable, it accords with the analyses of all three of the chemists just mentioned, much better than the formula hitherto adopted. To make this apparent I subjoin them. In the second column opposite the word ammonia I have grouped together the atoms NH_3 derived partly from the substituted ammonia and partly from the 2HO in order to complete the comparison of the results of calculation and analysis.

	Calculated according to the old formula $HgNH_2+2HgONO_5$.	Calc. by the formula here proposed $\left.\begin{matrix}Hg_2\\H\end{matrix}\right\}NONO_5+2HO$.	Found. Kane.	C. G. Mitscherlich.	Pagenstecher.
Mercury,	77·72	75·95	76·41	75·47	74·12
Ammonia, $\left\{\begin{matrix}\text{Amid}\\NH_2\end{matrix}\right\}$	4·15	(NH_3) 4·30	3·78	4·40	
Oxygen,	(2O) 4·15	(3O) 6·08		6·05	5·92
Nitric acid,	13·98	13·67	12·66	14·33	$\left.\begin{matrix}NH_4O\\NO_5\end{matrix}\right\}$ 17·40
	100·00	100·00		100·25	

It becomes at once evident on inspection that the formula I here propose is greatly more in accordance with the analyses than the old one. The mercury agrees better with all of them; the ammonia and nitric acid at least equally well. But it is (as was to be expected) in the oxygen that the difference is most striking. Mitscherlich and Pagenstecher found 6·05 and 5·92: the new formula gives 6·08, the old 4·15. This would seem to be conclusive.

Philadelphia, Oct. 1st, 1861.

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ART. XLII.—*An Instrument designed to illustrate certain resultant vibrations in Polarized Light;* by Prof. E. S. SNELL, Amherst College.

I HAVE lately designed and constructed an instrument for exhibiting the combinations of two rays of light, polarized in planes at right angles to each other, when they coincide in direction, but one is in advance of the other by any fraction whatever of the wave-length.

I am aware that an instrument for presenting these resultant forms and motions has been invented by Plucker, a German physicist. But it appears to me that its mechanical difficulties must be so serious, as to render it practically useless. There is also much inconvenience in attempting to show by it one polarization by itself, then the other, and finally some resultant of both combined. Besides, after sending forward two or three waves at most, the process comes to an end, and there must be a backward movement, before another progression of waves can be shown. I have never seen one of Plucker's instruments in operation, but the description and engravings satisfy me, that unless the parts are almost absolutely free from friction, the rods will bind on the surfaces and in the grooves, and stop all progress, or become bent in the attempt to continue the motion.*

The apparatus here described is free from these several objections. The friction of the parts has no tendency to make them bind against each other, and thus check the motion of the waves; the change can be made in a moment from each single polarized system to the other, and to any desired combination of the two systems; and finally, the series of waves, of whatever kind, passes along uninterruptedly, so long as the experimenter chooses.

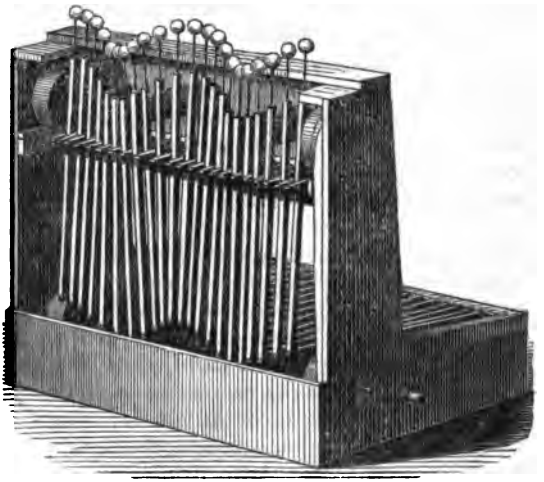
The general plan of giving motion to the rods which carry the balls is the same as that employed in the instrument for showing the molecular motion in water-waves, an account of which was published in this Journal, October, 1845, and which has recently been figured and described in Mr. Ritchie's catalogue of philosophical apparatus. Fig. 1 is a perspective view of the instrument, when opened so as to show the mechanism. The balls at the top represent so many particles of the luminiferous ether. They receive their vertical motions from the cams on the lower axis, which is turned by the crank (*a*); and their horizontal motions from a similar system of cams on the upper axis, which is made to revolve by a band from the lower. Fig. 2 presents a view of one of these systems of cams, twenty-four in

* For a description and representations of Plucker's instrument, see "Introduction a la Haute Optique, par A. Beer, traduit par M. C. Forthomme," pp. 148–153.

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number, of circular section, and arranged in a regular helix, making two revolutions from end to end. The upper and lower axes, so far as the cams are concerned, are precisely alike, and parallel; and by means of a metallic band and pins, they have the same velocity of revolution, whenever the lower one is turned. The lower axis is placed near the front of the box, and on each cam rests a horizontal rod or bar of wood, eighteen inches long, free to revolve in a vertical plane on a pivot at the back side of the box. The rods lie between guides, which prevent lateral motion. On the front extremity of each bar there stands another bar, upright, fifteen inches long, the two being pivoted together by a joint which allows free motion. These vertical rods also play between guides, (*c*), which permit motion in vertical planes coincident with those in which the horizontal bars respectively move. An elastic cord, about three inches long, is fastened to each pair of rods near their angle of meeting, and tends by its contraction to hold back the vertical rod against its cam on the upper axis. Inserted in the extremity of each vertical rod is a black iron wire, reaching through a slit in the top of the box, having a white ball upon it, which thus appears in sight, when all the mechanism is concealed from view.* The whole vertical rod, from the hinge to the ball, is eighteen inches long, the same as the horizontal bar. Fig. 1 presents one of the resultant forms of wave, when the rods are in contact with their respective cams on both axes.

1.



2.



Back of the lower axis, and below the horizontal bars, lies a strip of board, which can be turned up on hinges, so as to lift all the bars off from the cams; a similar piece is hinged below the upper axis, and behind the vertical rods, which, being turned

* The top piece containing the slits is not represented in the figure.

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into a horizontal position, presses the rods forward, and releases them from the upper cams. While they are placed thus, all the lower bars lie in a horizontal plane, and the upright ones in a vertical plane, so that the balls are in a straight line, representing the particles of ether at rest. If the crank is turned, both systems of cams revolve, but produce no motion of the balls. If the lower support is turned down, the horizontal bars fall upon their respective cams, the balls assume the arrangement of vertical waves, and on turning the crank, the wave-motion is seen in a *vertical plane* alone, representing a *plane-polarized pencil of light.* Now let the lower support be raised again, and the upper one be turned down; then the vertical rods are held back by the elastic cords against the upper system of cams, while the pivots at the bottom are in a horizontal line. If the crank is now turned, the lower cams produce no effect, but the upper system, revolving by the band, gives the balls a wave-motion in a *horizontal plane*, thus representing a pencil of light *polarized in a plane at right angles to the former.* Finally, if the lower support is once more let down, and the crank turned, the vertical waves coexist with the horizontal ones, and *some resultant mode of polarization is represented*, the precise character of which depends on the relation of phases in the two systems. The contrivance for varying the species of polarization, by bringing together any phases we please, is very simple. On the lower axis, the cams are all firmly attached to the short cylinder about which the band passes; but on the upper axis, the cylinder is divided, and the band passes over the detached portion or wheel, which is free to revolve on the central axis, but which can be held in any give position upon it, by a tooth on the main cylinder, which tooth is forced by a spring into a notch on the edge of the wheel. The wheel and spring are seen in fig. 2. Hence, by raising the tooth and turning the crank, the lower axis revolves, giving rotation also to the wheel, but not to the upper axis, until the balls assume the required relation to each other, when the tooth is dropped into the corresponding notch, and the desired polarization is produced, and can be continued at pleasure.

The resultant modes of polarization, as theory shows, are the following:

(1.) *Plane polarization*, the vibrations being in a plane inclined 45° to the right.

(2.) *The same*, the plane inclined 45° to the left.

(3.) *Circular polarization*, the atoms revolving from the right over to the left.

(4.) *The same*, the revolution being from left over to right.

(5.) *Elliptical polarization*, the transverse axis inclined 45° to the right, and the atoms revolving from right over to the left.

(6.) *The same*, and the axis the same, but the atoms revolving from left to right.

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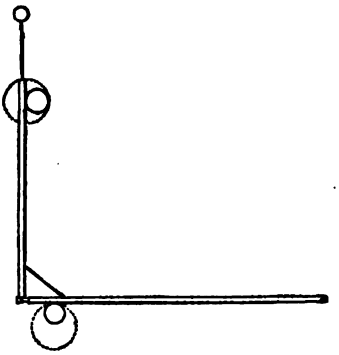
(7.) *The same*, the axis inclined 45° to the left, and the atoms revolving from right to left.

(8.) *The same*, and the axis the same, but the atoms revolving from left to right.

Moreover, in all the cases of elliptical polarization, the excentricity may vary to any degree, from the straight line on the one hand, to the circumference of a circle on the other.

It is unnecessary to state what is the relation of the cams of the two axes, for presenting all these varieties of polarization; to describe one or two is sufficient. Let a cam of the lower axis, Fig. 3, be at its highest position, and about to descend to the right, while the corresponding cam of the upper axis is farthest to the right, about to commence its motion to the left, as it descends; then the ball both *descends* by the first cam, and *moves to the left* by second, at equal rates; and therefore oscillates in a plane, which inclines upward 45° to the right. All the balls in regular succession do the same, so that the polarization is that of (1.) Again, change the relation of the axes, so that when one of the lower cams is at the highest point, the corresponding upper one shall be also at the highest point; then, when the ball *descends* by the first motion, it *moves to the right* by the second, till a quadrantal arc is described; then, continuing to descend, it moves to the left, till a semi-circumference is completed, and so on. This is *right-hand circular polarization* (4), provided the vibrations are propagated from particle to particle *toward the observer*. These and the other cases can be exhibited by the instrument in less time than is required to describe them.

3.



In one particular this instrument is inferior to Plucker's. In his, the balls in their component motions, strictly describe straight lines, in a vertical or a horizontal plane. But in this, these molecular motions, as exhibited by the balls, are obviously arcs of circles; consequently, all the compound motions deviate from the lines which have been mentioned. As the radius, however, is 18 inches, and the arc only about two inches, the curvature is not easily noticed. Since the whole purpose of the instrument is to produce motions which visibly agree with those determined by theory, in order to illustrate the subject to the mind of the pupil, the failure to fulfil the exact theoretical conditions is unimportant, while the mechanical advantages of this mode of producing the vibrations are obvious.

Amherst, Mass., Oct. 4, 1861.

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Art. XLIII.—*Arsenic as an Impurity of Metallic Zinc;* by Chas. W. Eliot and Frank H. Storer.

[*Remark:*—We now cite in full from their memoir on 'The impurities of Commercial Zinc' (*Mem. Am. Acad.*, vol. viii, 1860), the researches of Messrs. E. & S. on the interesting and often mooted question of the frequent presence of arsenic in commercial zinc. We thus redeem our promise given at the close of our former notice of this memoir (vol. xxxi, 147), and take pleasure in placing this fine research within easy reference by American readers. Its value in a medico-legal point of view cannot be too highly estimated.—Eds.]

The general opinion that arsenic is a very common impurity in commercial zinc may, we think, be traced back to the confident assertion of Proust, near the beginning of this century, afterwards extensively copied and generally believed. But it is quite clear that Proust, and probably many other of the early chemists, were led into error by the close resemblance of the sulphid of arsenic to the sulphid of cadmium, which last metal, not recognized till 1817, has since been shown to be a very common admixture in the zinc of commerce. The invention of Marsh's apparatus, in 1835, gave to chemistry a test for arsenic of most wonderful delicacy; and Marsh* himself, in his original memoir, describing his process, remarks, "that the only ambiguity that can possibly arise in the mode of operating above described, arises from the circumstance that some samples of the zinc of commerce themselves contain arsenic." But Marsh, thus careful to suspect his zinc, says not a word about the purity of his acid, and many observers since Marsh have been more ready to attribute the infinitesimal trace of arsenic, which his process has enabled them to detect, to the zinc, than to the acids they have used. Schauefele† has actually attempted to determine quantitatively the per cent of arsenic present in French, Silesian, and Vieille Montagne zincs, and his results have been quoted in many recent handbooks and treatises on toxicology.

The conclusions at which we have arrived, after a long course of experiments with many different zincs, and various acids, are these:—first, that much of the zinc of commerce is free from arsenic, or at least contains no arsenic that can be detected by the most delicate tests known for that metal; secondly, that the sulphuric and chlorhydric acids found in commerce do very often contain arsenic, and are always so liable to contain it as to be utterly unfit for use in Marsh's process without special purification for that purpose. The steps by which we were led to these results, and the evidence on which they are founded, we proceed to describe.

We have used exclusively Marsh's process for the detection of arsenic, applied with the apparatus and with all the precautions recommended

* Edinburgh New Phil. Jour., xxxv, 235.

† Extract from a thesis presented by M. Schauefele. Jour. de Chimie Médicale, [3], vi, 173; also in Dingler's Polyt. Jour., 1850, cxvi, 248.

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by Otto.* Our apparatus consisted of a flask provided with a funnel-tube, and a tube bent at right angles, with which were connected by connectors of sheet India-rubber, first, a tube of the form of a chlorid of calcium tube, filled with asbestos; secondly, a similar tube, filled with pumice-stone soaked in caustic potassa; and thirdly, one filled with chlorid of calcium. Through these three tubes, in the order in which they are named, the gas generated in the flask was obliged to pass before it arrived at the reduction-tube, which was of hard German glass, and about one centimetre in diameter. The reduction-tube was drawn down to a fine bore, and during the progress of an experiment was heated by one of Bunsen's triple gas-burners. To prevent any elevation of the temperature in the flask during an experiment, it was immersed in cold water, and the dilute acid used was always cold, and added in small quantities. With this apparatus (which for convenience we shall designate as Otto's apparatus), taking every possible precaution to insure its perfect cleanness, we made several experiments upon Silesian zinc. 200 grammes of this spelter, carefully granulated, were used in each experiment, and the sulphuric acid employed was a commercial acid made in this country from Sicily sulphur. We were not unaware of the fact, that arsenic is almost invariably found in the foreign sulphuric acid made from various impure sulphurs of unknown origin, or from pyrites;† but it is a common impression that the American acid manufactured directly from Sicily sulphur is free from arsenic. Positive statements to this effect have been made by chemists who have had mainly in view the common use of sulphuric acid in the preparation of chemical compounds used in pharmacy, and the assertion has enough plausibility to command ready and general belief. Using such acid and 200 grammes of granulated Silesian zinc, we obtained, at the end of the hour during which the reduction-tube was heated, a deposit of arsenic perfectly distinct, though not bright enough to be called a mirror. Our next experiment was made with the same acid upon 200 grammes of an excellent sample of Vieille Montagne zinc, perfectly clean and carefully granulated. At the end of the hour during which the gas was passed through the reduction-tube, a brownish, volatile coating was found in that part of the tube where the bore was smallest. These experiments on Silesian and Vieille Montagne zincs were several times repeated, and always with the same result; the deposit in the reduction-tube was often too thin and slight to be positively identified as arsenic, but it could not be distinguished from the deposit of that metal, and would have been perfectly fatal in a medico-legal investigation, or in any case in which absolute purity of the materials was desired. Not convinced that the zincs were the source of the arsenic, we desired

* A Manual of the Detection of Poisons. Translated from the German by Elderhorst. New York: Baillière. 1857.

† On the subject of arsenic in foreign sulphuric acid, the following authorities may be referred to:—Martius, Schweigger's Jour. f. Ch. u. Phys., 1811, iii, 363. Wackenroder, Ann. der Pharm., 1834, xii, 189. Ib., 1835, xiii, 241. Vogel, Jour. f. pr. Ch., 1835, iv, 239. Ficinus, Ann. der Pharm., 1835, xv, 77. Berzelius, in his Jahresbericht, 1841, xx, 192. Brett, Philosophical Mag., 1842, [3], xx, 404. Schneedermann and Wöhler, Jour. f. pr. Ch., 1845, xxxv, 186. Dupasquier, Comptes Rendus, 1845, xx, 794. Cameron, Chem. Gazette, No. 320, p. 75, in Jour. f. pr. Ch., 1856, lxviii, 64.

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to prepare a quantity of sulphuric acid in which the presence of arsenic could not possibly be suspected. To attain this object, we subjected a specimen of American sulphuric acid to the following process. The acid was first boiled with a little flowers of sulphur, as proposed by Barruel,* in order to free it from the nitrous fumes which the common sulphuric acid almost always contains; a small quantity of pure chlorhydric acid was then stirred into the cooled acid, which had been carefully decanted from the free sulphur, and the whole again boiled; to the acid, again cooled, a second addition of chlorhydric acid was made, and again the acid was heated till dense white fumes had been escaping for upwards of half an hour. During this process, the volatile chlorid of arsenic is completely driven off, the second addition of chlorhydric acid being made, as has been recommended by H. Rose,† in order to insure this result. Lastly, a portion of chlorine-water was added to the cooled acid to oxydize any sulphurous acid which might be contained in it, and after a third boiling, the acid, cooled and diluted with three parts water, was ready for use. This method of purifying sulphuric acid is a combination and modification of several well-known processes. Buchner‡ has described in full the process of purifying sulphuric acid by means of chlorhydric acid, and the use of chlorine as above described was recommended by Jaquelain.§ The whole operation can be performed in a shallow evaporating-dish, and presents no serious difficulties of any kind. With the acid thus prepared, we tested 200 grammes of Vieille Montagne zinc, and after passing during more than an hour a continuous, gentle stream of gas through the reduction-tube, of which about four centimetres were maintained at a bright red heat, we found that there was absolutely no deposit whatever in the cool and narrow part of the reduction-tube. With the same acid and apparatus, 200 grammes of Pennsylvanian zinc (which had been proved to be altogether the purest zinc in our possession) gave absolutely no deposit of any kind in the fine reduction-tube at the end of one hour, the time during which, in all our examinations for arsenic, we maintained a steady flow of hydrogen through the red-hot reduction tube. We had now demonstrated that two different spelters, of which we were fortunate in possessing considerable quantities, were free from arsenic, or, more strictly, that in the given quantities of metal, and in the stated times, Marsh's infinitely delicate test could not detect arsenic in these two zincs. It was also rendered very probable that the sulphuric acid with which we first experimented contained arsenic, inasmuch as we had obtained a distinct deposit of arsenic from that acid and the Vieille Montagne zinc, which subsequent experiment had proved to be free from that impurity. In order satisfactorily to establish these conclusions, it was necessary to prove by frequent repetition that the same result might always be expected from these two zincs, and that their freedom from arsenic was a property shared by the whole sample, and not an accidental peculiarity of a particular fragment. At sundry times we therefore repeated again and again the long and careful test for arsenic above described with these two samples of spelter, and invariably arrived at the same conclusion; namely,

* Dingler's Polyt. Jour., 1837, lxiv, 55; from Jour. de Ch. Médicale, 1836, No. 4.
† Pogg. Ann., 1858, cv, 571. ‡ Ann. der Ch. u. Pharm., 1855, xciv, 241.
§ Ann. de Ch. et Phys., 1843, [3], vii, 191.

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that no deposit of any kind could be obtained in the reduction-tube from these zincs and purified sulphuric acid.

Delicacy of the Test.—To prove the sufficiency of our apparatus, and the absence of every substance which might be supposed to prevent the formation of the arsenic mirror, and, moreover, to obtain mirrors from known quantities of arsenic with which roughly to compare deposits obtained in experiments in which the arsenic was the unknown quantity, we made the following experiments:—

1. 200 grammes of Vieille Montagne zinc, about 200 c. c. of purified dilute sulphuric acid, and 20 drops of pure chlorhydric acid, were first thoroughly tested for arsenic, and found to be perfectly pure.

2. 200 grammes of Vieille Montagne zinc, and about 200 c. c. of purified sulphuric acid, were thoroughly tested, and gave no deposit in the reduction-tube. Into the flask whose contents had been thus proved, two tenths of a milligramme of arsenious acid (weighed on a Plattner's assay balance, made by Lingke of Freiberg), dissolved in 20 drops of the same chlorhydric acid used in the first experiment, were introduced. An enormous mirror of arsenic appeared instantly in the reduction-tube. To get the greatest effect, the arsenious acid should be thoroughly dissolved, and its solution should be effected without the use of any but a very gentle heat.

3. Using the same zinc and the same acids, in the same quantities which were employed in the foregoing experiments, and proving the materials as in the last experiment, we obtained in half an hour, a very large and distinct mirror of arsenic, by introducing into the flask one tenth of a milligramme of arsenious acid.

4. 200 grammes of Pennsylvanian zinc and about 200 c. c. of purified sulphuric acid were tested for one hour, and proved to be perfectly pure. One milligramme of arsenious acid had been dissolved in 20 drops of the pure chlorhydric acid which had been used in the first experiment, and the solution diluted with distilled water to the bulk of 50 c. c. One cubic centimetre of this solution was introduced into the flask whose previous contents had been proved as above described, and at the end of three quarters of an hour a distinct deposit of arsenic was found in the reduction-tube. The amount of arsenious acid actually placed in the flask was two hundred-thousandths of a gramme (.00002 gram.).

$$0{\cdot}00002 \text{ grm. arsenious acid} = 0{\cdot}000015 \text{ grm. arsenic.}$$

Ratio of the arsenic present to the zinc $= 0{\cdot}000015 : 200 = \frac{75}{1{,}000{,}000{,}000}$.

" " " " " amount of liquid in the flask = about $\frac{75}{1{,}000{,}000{,}000}$.

Our apparatus was therefore competent to detect a quantity of arsenic less than one ten-millionth of the weight of the zinc used, or of the amount of fluid in the flask. This quantity of liquid necessarily varied somewhat, in consequence of the slight additions of acid necessary to maintain a constant current of hydrogen, but only varied to be increased, never diminished. Remembering the wide limits of error in many chemical processes, the comparative coarseness of most chemical tests, and the many unavoidable inaccuracies in weighing and measuring, is not the assertion perfectly safe, and in strict conformity with the general use of language in other qualitative or quantitative determinations, that a specimen of

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zinc is free from arsenic, which does not show the slightest trace of that metal in an apparatus abundantly capable of detecting the ten-millionth part of arsenic? We are aware that this is not the limit of delicacy* of Marsh's test, but, assured of this delicacy, we rest satisfied with it as sufficient for our present purpose. The more delicate the test, the stronger is our present argument, and the greater need is there of exceeding caution in applying this test in the investigations of medico-legal or pharmaceutical chemistry.

In connection with these experiments on the delicacy of the test, we would call attention to the fact, that the sulphuretted hydrogen, which we have shown in our examinations for sulphur to be always developed from commercial zinc, does not prevent the exhibition of such a very small amount of arsenic as 0·000015 gram. Chevallier,† and more recently Blondlot‡ and Leroy,§ assert that the presence of the insoluble sulphid of arsenic cannot be recognized by Marsh's test, and that arsenic may therefore be concealed by being converted into the sulphid. This is the natural and general opinion, though Marsh, in his original memoir, distinctly says, that "the presence of arsenic in artificial orpiment and realgar, ... and in sulphuret of antimony, may be readily shown by this process, when not more than half a grain of any of those compounds is employed."‖ When the amounts of arsenic and of sulphuretted hydrogen are alike minute, it is quite certain that the reaction for arsenic is not affected by the unavoidable presence of this gas.

Arsenic in American Acids.—We have tested four different kinds of American sulphuric acid, of which two were commercial oil of vitrol, and two were sold as chemically pure acids. The test applied to these acids was always the same, and may be described once for all: 100 grammes of Pennsylvanian zinc, from the same bar which in many trials had been shown to be free from arsenic, was placed in the flask, and the acid to be tested was used instead of the purified acid which was always employed when the zinc was the suspected substance. In every experiment, the gas was passed through the reduction-tube at least one hour. In experiments several times repeated, the sulphuric acid made at Providence, Rhode Island, invariably yielded a distinct deposit in the narrow part of the tube. It should be stated, however, that the Providence acid used in these repeated experiments all came from one carboy. In a sample of the acid made at Waltham, Massachusetts, we detected a similar trace of arsenic. The deposits obtained from these two acids were hardly larger than that produced by the 0·000015 gram. of arsenic used in the fourth experiment on the delicacy of the reaction, but, on the other hand, only a small quantity (from 25 to 50 c. c.) of the acid could be employed in a single experiment.

The arsenic which is eliminated from these acids during the process of purification with chlorhydric acid may easily be collected, and exhibited

* M. Signoret (Taylor on Poisons, 2d Edition, 1859, London, p. 396) states that he has procured metallic deposits with only the 200,000,000th part of arsenic in the liquid; but it is not clear from such a statement what the exact amount of arsenic in the apparatus was which enabled him to obtain deposits,—a very material point.

† Jour. de Ch. Méd., [2], v, 380, in Berzelius's Jahresbericht, 1841, xx, 192.

‡ Comptes Rendus, 1857, xliv, 1222. § Ibid., 1859, xlix, 469.

‖ Edinburgh New Phil. Jour., xxxv, 235.

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by Marsh's test. For this purpose, the sulphuric acid should be heated with the chlorhydric acid in a flask or retort, from which the gas generated is conducted into a small quantity of distilled water, kept constantly cool. The volatile chlorid of arsenic condenses in the water, and the arsenic in the solution is readily manifested in Otto's apparatus. The chlorhydric acid used in this experiment must be absolutely free from arsenic; such acid may be obtained by passing sulphuretted hydrogen through chlohydric acid prepared from salt and pure sulphuric acid. Moreover, the sulphuric acid in the flask or retort must be kept fuming during at least half an hour, in order to secure the complete volatilization of the chlorid of arsenic.

The chemically pure sulphuric acid, so called, manufactured by Rosengarten, of Philadelphia, was purer than the commercial acid with reference to arsenic as well as to lead; indeed, in one experiment it yielded no sensible deposit in the reduction-tube, but in several subsequent experiments with pure zinc, in which we attempted to use Rosengarten's acid instead of that purified by ourselves, we obtained faint deposits which precluded its use, and showed it to be untrustworthy in such delicate examinations for arsenic by Marsh's process. To the "chemically pure" sulphuric acid made by Powers and Weightman of Philadelphia, precisely the same remarks apply; it is unfit for use in any research where scrupulous accuracy is necessary, and of which the results are worse than worthless if they be not certain and impregnable. It may be granted that the amount of arsenic in any small quantity of these acids is really too minute to be of any consequence, except in the most refined experiments. On the other hand, it must be remembered that in some pharmaceutical processes, and in many chemico-legal examinations for arsenic, in which a large amount of acid is often necessarily used, the whole of the arsenic contained in the reagents employed is, by the very nature of the process, concentrated and condensed into a very small compass. For example, in a poisoning case in which the chemist is obliged to destroy by acids any considerable portion of the body, as is often the case, it may be necessary to use many pounds of sulphuric or chlorhydric acid, and the very care and pains with which the chemist labors to concentrate every grain of arsenic in that organic matter into the small glass of liquid, which he finally tests by Marsh's process, also concentrates into the same glass all the arsenic contained in all the reagents which he has employed in the whole process. Under such circumstances the existence of *any* arsenic in sulphuric acid, capable of exhibition from a few cubic centimetres of the acid, becomes a fact of the utmost moment. From neglecting this arsenic in sulphuric acid arose the long controversy concerning normal arsenic in the animal body. To the objection that Marsh's test is too delicate, and that we should find all the elements everywhere if we had for each of them a test as refined as Marsh's for arsenic, it may be replied, first, that Marsh's process is not thought too delicate to base vital conclusions upon in difficult examinations for arsenic in poisoning cases, and secondly, that facts are not to be met by a theoretical objection, which is at any rate purely speculative, and furthermore is no objection if, as is certainly possible, the theory be true.

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We are aware of the common opinion, that sulphuric acid made from Sicily sulphur contains no arsenic,* and we do not propose to explain the source of the arsenic found in American sulphuric acid, further than to suggest that its presence seems not unnatural when we remember that the sulphides of arsenic are often associated mineralogically with the sulphur from which the acid is made. Long ago Pfaff,† in commenting upon the observation made by Martius of arsenic in sulphuric acid, said that the sample analyzed by Martius was probably made from sulphur containing orpiment or realgar, minerals which are found with sulphur in the solfataras. Stromeyer‡ detected arsenic in the mixture of sal-ammoniac and sulphur, which is one of the many volcanic products of the Lipari Islands, and there seems to be no good reason for supposing that the sulphur, which is exported from that locality, would escape contamination with arsenic. Daubree§ has remarked that arsenic, as sulphid, occurs in the fissures of the lavas at Etna, at Vesuvius, and at the solfataras of Pouzzoles and of Guadeloupe. Scacchi‖ also states that among the substances found in the fumaroles of the solfataras are pyrites, realgar, mispickel, and dimorphine. Orfila,¶ and before him Vogel, of Munich, imply that the leaden chambers in which sulphuric acid is made communicate arsenic to the acid.

Whatever we have said with regard to the American sulphuric acid, applies with still greater force to the commercial chlorhydric acids. That common chlorhydric acid contains chlorid of arsenic, is a fact which was long ago observed, and has been fully discussed by Wackenroder,** Dupasquier,†† Otto,‡‡ and many others.§§ We have examined two different samples of chlorhydric acid made in this country. Dilute chlorhydric acid, instead of sulphuric, was used in Marsh's apparatus with 200 grammes of pure Vieille Montagne zinc, and before the hydrogen generated had been passing through the heated reduction-tube fifteen minutes, there appeared in the fine part of the tube a brown deposit, which in an hour increased to a large and distinct mirror of arsenic, readily verified by other tests. Both samples of acid gave the same result, and we may add that, even on a small scale, we found great difficulty in preparing from salt and sulphuric acid a specimen of chlorhydric acid perfectly free from arsenic. The thorough purification of the acid by means of sulphuretted hydrogen, as recommended by Otto, is therefore an absolutely necessary preliminary to the use of chlorhydric acid in an examination for arsenic.

From the examination of so few samples of sulphuric and chlorhydric acids, we do not pretend to have established the affirmative proposition, that there is always arsenic in these acids; their impurity was only an incidental difficulty in this research, and we strayed thus far from our main subject, only because of the great importance of trustworthy infor-

* For a strong statement of this opinion, see Ure's Dictionary of Arts, &c., 4th edition, Boston, 1853, vol. ii, pp. 791, 799.

† Schweigger's Jour. f. Ch. u. Phys., 1816, xviii, 283.

‡ Ibid., 1825, xliii, 452.

§ Ann. des Mines, [4], xix, 680.

‖ Journal f. pr. Ch., 1852, lv, 54.

¶ Ann. d'Hygiène Publique, xxii, 406.

** Ann. der Pharm., 1835, xiii, 241.

†† Comptes Rendus, 1841, xiii, 630.

‡‡ Ann. der Ch. u. Pharm., 1856, c, 39.

§§ See also Ure's Dictionary of Arts, &c., 4th edition, (Boston, 1853,) ii, 248, Art. *Muriatic Acid.*

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mation upon this point to the pharmacist, and to the chemist who has to do with poisoning cases. Our observations, in connection with the facts long since established regarding the contamination of foreign sulphuric and chlorhydric acids with arsenic, may well lead the pharmacist and the analytical chemist to distrust his acids, till accurate experiments have proved them to be above suspicion; and we believe that careful investigations will hereafter show that arsenic is introduced into pharmaceutical preparations by the acids employed in their manufacture to an extent far greater than would now be credited. The task of the chemist who is called upon to examine a human body or organs of the body for arsenic, is a simple one when the poison is found in its original condition, unabsorbed and unaltered, but in difficult investigations of this kind, when the poison has been absorbed and diffused through a large mass of organic matter which must be destroyed by acids, the precautions insisted upon by Gaultier de Claubry,* and by Galtier,† and other modern toxicologists, should be strictly observed. Not only should all the reagents to be employed be thoroughly tested *à blanc*, but furthermore, an experiment parallel with the actual examination of the suspected organic substances should be carried on with the same reagents in the same quantities, in a similar apparatus, and in all respects under like conditions, upon a quantity of normal animal matter equal to the weight of the suspected substances. In this way only can the chemist avoid the fatal uncertainty consequent upon the employment, in large quantity, of reagents whose purity is not above suspicion.

We return to the examination of other zincs for arsenic. With the same purified acid used in our previous experiments on Pennsylvanian and Vieille Montagne zincs, we tested 200 grammes of *Silesian* zinc, carefully granulated, and perfectly clean. For half an hour, the hydrogen passed steadily through the red hot reduction-tube without leaving the slightest deposit in the fine tube beyond the heated portion, but on continuing the operation beyond this time (indicated by Otto as sufficient for the testing of the materials *á blanc*), a faint but perceptible mirror gradually formed. This result indicates, first, that this sample of Silesian zinc was not perfectly free from arsenic, and secondly, that it is dangerous to conclude that the zinc and acid, which have given no reaction for arsenic during half an hour in Otto's form of Marsh's apparatus, will therefore give no mirror in the next half hour, even though no arsenical compound be added to the apparatus. In any delicate examination for arsenic, this is a point to be carefully borne in mind. Our results with this zinc were corroborated by several similar experiments.

The zinc of Rousseau Frères was next submitted to the same test, with the same acid: 75 grammes of this zinc yielded in half an hour a brown deposit, hardly to be called a mirror, although covering a considerable portion (two centimetres) of the tube. The final result of the experiment was not distinguishable from the result of the test of Silesian zinc.

With the same acid and apparatus, 200 grammes of New Jersey zinc gave a distinct mirror of arsenic, so large in amount, that the arsenic

* Briand et Chaudé, et Gaultier de Claubry, Manuel complet de Médecine Légale, 5me édition, (Paris, 1852.) p. 752.

† C. P. Galtier, Traité de Toxicologie, (Paris 1855,) Tom. i, p. 362.

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could be easily recognized by its characteristic odor. The mirror began to form at once, and gradually increased during the hour, which was the duration of the experiment.

Having at hand a quantity of the ore from which this zinc is extracted, we extended our search for arsenic to the red oxyd of zinc, which is the source of this spelter. Several grammes of the red oxyd, finely powdered, were moistened with 30 drops of pure nitric acid, and treated with a measured quantity of pure chlorhydric acid, prepared from common salt and sulphuric acid free from arsenic. The solution, with the very slight residue, was then gently evaporated to a small bulk, with a small measured quantity of Rosengarten's sulphuric acid. The imperfect solution thus prepared was introduced into the flask of our apparatus, whose previous contents of zinc and acid had been thoroughly tested for one hour, and found perfectly pure. In ten minutes a distinct deposit of arsenic was obtained, which in half an hour increased to a large and unmistakable mirror. To prove beyond a doubt that this arsenic came from the oxyd of zinc, and not from the acids employed in preparing the solution, we tested in a clean apparatus with fresh zinc and acid, which had been proved pure by a test of one hour in duration, the same quantities of the same acids evaporated together as in the experiment above described. At the end of one hour (the second hour during which the apparatus had been at work) a deposit, perceptible on close inspection, was discovered in the narrow part of the reduction-tube. This deposit was invisible on any cursory examination, and bore no comparison with the very decided mirror of arsenic obtained in the previous experiment. In two other similar examinations of the red oxyd of zinc, we obtained the same strong evidence of the presence of arsenic in this ore, and the associated mineral, Franklinite, yielded, in the single careful test to which we subjected it, a mirror of arsenic sufficient to give the smell and all the other characteristic reactions for arsenic. To obtain satisfactory results, the solution of the oxyd must never be heated above 100°, and the small quantity of nitric acid which is used to facilitate the solution must be completely driven off before the liquid is introduced into the apparatus.

If any further evidence of the presence of arsenic in the New Jersey spelter and its ore were needed, it might be found in the following experiment with a zinc which we ourselves prepared by reducing the New Jersey white oxyd of zinc with charcoal, in a refractory retort such as are furnished by the dealers in chemical apparatus at Paris: 20 grammes of this zinc, tested in Otto's apparatus with purified sulphuric acid, yielded in five minutes a distinct deposit of arsenic, and in half an hour a large mirror.

To ascertain whether the Pennsylvanian and Vieille Montagne zincs were always free from arsenic, we procured and tested another sample of the zinc manufactured at the Pennsylvanian and Lehigh zinc works, and a second sample of Vieille Montagne spelter. The Pennsylvanian zinc was, as before, remarkably free from lead, leaving no residue when dissolved in dilute sulphuric acid; but on testing 200 grammes of it in Otto's apparatus with purified acid, it gave in half an hour a slight deposit in the reduction tube, which in an hour increased to a distinct brown coating. A similar result we obtained in testing the second sample of

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Vieille Montagne zinc; 200 grammes of it with pure acid yielded a deposit in the reduction-tube, fatal to its use in any delicate experiments. It should be stated, that the external appearance of this spelter indicated very clearly that its quality was inferior to that of the sample first examined. It is obvious from these results, that zinc manufactured in the same works, and from the same ore, may not always contain the same impurities, or rather that it is never to be expected to contain the same percentage of the same impurities. From the nature of the process of reduction, it would naturally be the case that the more volatile impurities should be present in the zinc which distils first in greater quantities than in the zinc which is reduced from the last part of a given charge of ore. Thus it is easy to imagine that the zinc which comes over first should be contaminated with arsenic, while that which is last reduced might be perfectly free from that impurity. The same principle explains the variations in the amount of cadmium contained in different samples of the same spelter, and indeed accounts in great measure for the varying per cents of all the impurities found in different specimens of any zinc, though made by the same process from the same ore.

Lastly, we submitted our four specimens of English zinc to the test for arsenic. With purified acid, 200 grammes of the zinc made by Dillwyn and Company began to show a deposit in the reduction-tube within ten minutes of the commencement of the experiment, and in twenty-five minutes this deposit increased to a very perceptible mirror. A similar result was obtained from 200 grammes of the Mines Royal zinc. In fifteen minutes the stream of hydrogen from this zinc began to deposit arsenic in the reduction-tube, and at the end of three quarters of an hour, a thin but perfectly distinct mirror extended over three or four centimetres of the fine tube. On the label which accompanied the specimen of the spelter made at Minera, near Wrexham, it was stated that the zinc was manufactured from silicate of zinc, and we therefore expected to find this spelter purer than the ordinary English zinc made from blende; but, on the contrary, it contained a large amount of lead, and the test for arsenic showed it to contain more of that impurity than either of the two specimens before examined: 100 grammes of the Wrexham zinc began to show a deposit in the reduction-tube in ten minutes from the beginning of the experiment, and at the end of an hour a mirror had accumulated large enough to be identified by the arsenical odor. But of the four samples of English zinc, that of Messrs. Vivian contained the most arsenic; 200 grammes of this spelter yielded an enormous mirror of arsenic in less than ten minutes, and in a few minutes more a second mirror, large enough to give the characteristic odor. With regard to English zinc, therefore, our observations do not agree with those of Brett,* who states that he has examined many specimens of English and foreign zincs, and could never obtain any indications of arsenic when the sulphuric acid was pure. The explanation of this discrepancy is to be found in the fact, that the test applied by Brett, although essentially Marsh's test, had not the extraordinary delicacy which is insured by Otto's form of Marsh's apparatus.

* Philosophical Magazine, 1842, [3], xx, 404.

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This question now suggested itself: In presence of an excess of zinc, is not arsenic retained in the black residue (lead) from zinc dissolved in dilute acids, in such a condition, that it is not attacked by the acids or by the hydrogen, and therefore escapes detection? To determine this point, if possible, we dissolved 40 grammes of the Vieille Montagne zinc, which had showed no trace of arsenic by Marsh's test in dilute sulphuric acid, free from arsenic. The residue obtained was washed, treated with chlorhydric and a few drops of nitric acid, and the solution gently evaporated to a small bulk in presence of a little pure sulphuric acid. The mixture thus obtained was washed into the flask of Otto's apparatus, whose previous contents of zinc and acid had been thoroughly tested *à blanc* and found pure. At the end of the second hour, a very slight deposit was discernible on close inspection in the fine tube, but the result was too doubtful to warrant the assertion that arsenic was contained in the insoluble residue. We next tried the same experiment with Silesian zinc, in which Marsh's test had detected arsenic. The residue from 40 grammes of this zinc, submitted to the process just described, produced in the reduction-tube in fifteen minutes a brown deposit, which in half an hour became well marked, and at the end of the hour afforded sufficient evidence of the presence of arsenic in the residue, it being well understood that the zinc and acid used in this experiment had been previously tested for one hour and found pure. The only conclusion to which these experiments point is, that when a given sample of zinc contains arsenic, a portion of that arsenic will escape combination with the hydrogen generated by the solution of the zinc, and will remain in the insoluble residue. It was useless in this connection to examine the residue from New Jersey zinc, because that spelter itself contained arsenic, and its residue contained metallic copper, which would inevitably retain arsenic, as in Reinsch's test. The Pennsylvanian zinc gave no residue with acids.

The absolute necessity of obtaining zinc free from arsenic for many chemical investigations, renders any process for purifying zinc from arsenic a matter of considerable interest and importance. We therefore tried the process of purifying zinc by fusing it with one fourth of its weight of saltpetre, a method fully described by Meillet,* but previously suggested by Orfila:† 760 grammes of Silesian zinc were finely granulated and mixed with one fourth this weight of saltpetre, by placing the zinc and nitre in alternate layers in a Hessian crucible. The mixture was heated till deflagration ensued, when the melted mass was poured into cold water to separate the slag, caustic potassa, and any arseniate of potassa which might have formed. The washed mass was remelted, and again granulated. The loss of zinc during the process is very large; we obtained only 200 grammes from the original 760 grammes. Of this zinc 170 grammes were tested in Otto's apparatus with pure acid, and in twenty minutes there began to form in the reduction-tube a brownish deposit, which, at the end of three quarters of an hour, was a sufficient evidence of the presence of arsenic. The deposit was as large as that obtained from the same Silesian zinc, before it had undergone this process of fusion with nitre. It has already been stated, under the appropriate head, that this

* Dingler's Polyt. Jour., 1842, lxxxiii. 205; from Jour. de Pharmacie, 1841, p. 625.
† Annales d'Hygiéne Publique, 1839, xxii, 427.

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process did not disembarrass the zinc of the sulphur which it contained, and there seems to be little reason for expecting the complete removal of the arsenic, inasmuch as the fused saltpetre can only be brought in contact with the external surface of the zinc, however finely the metal may be granulated. It is not inconceivable that a trace of arsenic in a zinc should be eliminated by Meillet's process, and that a sample, originally almost absolutely free from arsenic, should be so improved as to afford no perceptible mirror; thus Stein* could not detect arsenic in a sample of zinc purified by this method, but as a general rule it will not be safe to rely upon this process for the conversion of arsenical commercial zinc into zinc fit for use in Otto's apparatus.

On this subject of arsenic in commercial zinc two opposite errors demand notice. On the one hand not a few chemists have maintained that commercial zinc almost invariably contains arsenic, and that Marsh's test is untrustworthy on this account. Thus Persoz† states that the greater part of the zinc sold in Strasbourg contains arsenic, and in a previous paper,‡ condemning Marsh's process, he remarks with truth, that even distilled zinc may give spots of arsenic. The opinion that all zinc contains arsenic, finds support in the quantitative determinations by Schauefele of the amount of arsenic in French zinc, Selesian zinc, and Vieille Montagne zinc respectively. These determinations have been quoted in almost all the modern text books, and have had in our opinion much more weight than they are really entitled to. Schauefele determined the arsenic in his samples of zinc by two methods. The first was that of Villain, and consisted in counting the number of arsenic spots obtained from a given weight of zinc, and estimating the corresponding amount of arsenic by means of the following absurd rule:—one milligramme of arsenious acid will give two hundred and twenty-six arsenical spots two millimetres in diameter. The utter unfitness of this process for exact experiments is too obvious to need any illustration. In applying this singular method, Schauefele completely dissolved one kilogramme of zinc in dilute *sulphuric acid*, but in this connection says not a word about the purity of the acid, of which he must have used at least one kilogramme and a half. The second method used by Schauefele was essentially that described by Jacquelain, and consisted in passing all the hydrogen generated by a given weight (from 320 to 800 grammes) of zinc through a solution of chlorid of gold; this solution was partially decomposed by the arseniuretted [sulphuretted?] hydrogen, and when the zinc had been completely dissolved, the chlorid of gold solution, which was supposed to contain all the arsenic of the zinc in the condition of arsenious acid, was further decomposed as completely as possible by means of *sulphurous acid*, and the precipitated gold separated by filtration. In the filtrate there still remained a small amount of chlorid of gold, which had escaped reduction by the sulphurous acid, and to separate this chlorid from the solution of arsenious acid, distillation was resorted to. The retort in which the residue from the distillation remained was washed out with water acidulated with *chlorhydric acid*, and the liquid so obtained was added to the original distillate, through which sulphuretted hydrogen was

* Jour. f. pr. Chem., 1851, liii, 40. † Ann. de Ch. et Phys., [3], 1844, x, 507, note.
‡ Ibid., [2], 1840, lxxiv, 432.

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then passed. The precipitated sulphid was collected on a filter, dried, and redissolved in *ammonia;* this ammoniacal solution was then evaporated to dryness, and the residue weighed as sulphid of arsenic. As the result of this complicated process, which involves the use of so many different reagents and vessels, Schauefele obtained a quantity of arsenic which varied between two thousandth of one per cent of the weight of the original zinc, in that sample which contained the most arsenic, and two five-thousandths of one per cent in that which contained the least. The weight of the sulphid of arsenic, which was the final result of the analysis, in no case exceeded ten milligrammes. There is no certainty that this very small amount of arsenic was not derived from the acids used in the process, for Schauefele merely states that his sulphuric acid, of which he used a very large quantity, was "absolutely free from arsenic," and the other reagents are said to be pure. The methods by which he insured this absolute purity are not even hinted at, and we therefore have no opportunity of judging for ourselves of the sufficiency of the processes employed to eliminate the arsenic from these reagents, of which two at least almost invariably contain appreciable amounts of that impurity. Quantitative determinations, in which the original weights are kilogrammes, and the final weight milligrammes, are trustworthy only when the processes are short and simple, and the reagents employed are proved to be above suspicion. The process of M. Schauefele was long and complex, and his reagents, so far from being proved to be above suspicion, were in all probability the source of the arsenic which he attributed to the zinc. In the valuable paper which we have before cited, Karsten distinctly states that the Silesian zinc is free from arsenic, basing this statement upon experiments which in their general method closely resembled those of Schauefele; he endeavored to decompose a solution of nitrate of silver by a stream of hydrogen generated by the zinc under examination, but though his process was analogous to that of Schauefele, he was led to the diametrically opposite conclusion. Again, Schauefele's second method was essentially the process which has been thoroughly studied by Jacquelain, who claims for it a delicacy* equal to that of Marsh's process; and yet in Jacquelain's own hands this method detected no arsenic in the specimen of zinc which he examined.† We cannot avoid the conclusion, that the determinations given in M. Schauefele's thesis have no general significance, and have gained more credit than they deserve. Our observations conclusively prove that there are zincs in commerce which are not contaminated with arsenic, and it should be noticed that, while one of our pure samples (the Pennsylvanian) was of a zinc which is not yet manufactured in large quantities, the other was a specimen of the Belgian zinc, one of the most common and abundant of the commercial spelters.

We turn now to the discussion of the opposite error, namely, that arsenic is very rarely to be found in the zinc of commerce. On this point we need only quote the strong statements of the highest authorities. Regnault, in the report‡ to the French Academy on Marsh's process and its modifications, wrote: "It is easy to procure in commerce zinc and sul-

* Ann. de Ch. et Phys., [3], ix, 490. † Ibid., 1843, [3], vii, 189.
‡ Comptes Rendus, 1841, xii, 1076, and Ann. de Ch. et de Phys., [3], ii, 159.

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phuric acid which gives no arsenic in Marsh's apparatus." With proper understanding with what is here meant by "Marsh's apparatus," this statement is as true now as it was twenty years ago. The committee relied chiefly upon the production of arsenical spots on porcelain, and though they recommended a form of apparatus adapted for heating the arseniuretted hydrogen to redness, yet in this apparatus the reduction-tube was not drawn down to a fine bore beyond the heated portion of the tube, and the committee in their own experiments seem to have preferred the arsenical spots as affording the best evidence of the presence of arsenic. They completely dissolved 500 grammes of commercial zinc in dilute sulphuric acid, and obtained from the hydrogen evolved no sensible arsenical spot; the black residue they did not examine. The test to which we have submitted our acids and zincs is more delicate than that applied by the committee of the French Academy; Otto's apparatus is more sensitive than that used by this committee, and will detect the presence of arsenic in quantities too small to produce sensible spots. It is self-evident that the continuous deposition of arsenic from a stream of hydrogen as it flows steadily through a very fine tube for an hour or more, would exhibit an amount of arsenic too minute to give the slightest perceptible spot in the instant during which the porcelain surface is held in the burning jet of gas. The first reaction is prolonged and accumulative, the second is intermittent and instantaneous. Blancard,* in commenting upon the statement regarding the ease of obtaining pure zinc, which is above quoted from the Report, has remarked with truth, that many zincs of commerce which give no *spots* by Marsh's apparatus, nevertheless contain sometimes antimony, sometimes arsenic, sometimes both.

The same explanation should accompany the statements of Orfila, with regard to arsenic in commercial zinc and acids. This distinguished toxicologist, in a very valuable paper on "The Means of being assured of the Presence of Arsenic," after remarking† that the sulphuric acid and the zinc of commerce sometimes contain arsenic, nevertheless implies‡ that he has never obtained decided arsenical spots on porcelain from a commercial sulphuric acid, and subsequently makes this explicit declaration: "I declare that I have made this experiment (the test for arsenic by the production of arsenical spots) more than five hundred times with the sulphuric acid and zinc of commerce, bought of various manufacturers of chemical products, and have only found arsenic *three times.*"§ Our own experiments confirm the truth of this statement; of all the specimens of zinc which we have examined, not more than two contained enough arsenic to give spots on porcelain, and not a single sample of our sulphuric acid would have afforded that reaction for arsenic. So long as the chemist, employed upon a poisoning case, sought for arsenical spots alone, the little arsenic which his zinc might have contained could do no harm; it is only when important conclusions are to be drawn from more refined experiments, with a more delicate apparatus, that the arsenic so often present in zinc and acids becomes a matter of a very serious concern. Our experiments prove that arsenic is contained, not in all samples of commer-

* Dingler's Polyt. Jour., 1841, lxxxii, 425, from Jour. de Pharmacie, Sept., 1841, p. 543.

† Annales d'Hygiène Publique, 1839, xxii, 404. ‡ Ibid., 411. § Ibid., 424.

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cial zinc, but in a large majority of them; and it will be perceived that we arrive at this result without impugning in the slightest the accuracy of the experiments upon which the very distinguished chemists whose words we have above quoted based opposite conclusions. * * * *

The purest of all the zincs which we have analyzed is that manufactured at the Pennsylvania and Lehigh Zinc Works, Bethlehem, Pennsylvania. This spelter dissolves in dilute sulphuric acid without leaving any appreciable residue, and therefore contains no lead; indeed a trace of cadmium is the only impurity whose presence in this zinc we could confidently assert. The ore from which this spelter is made is the hydrated silicate of zinc (electric calamine), and it is not surprising that this mineral should yield zinc of singular purity, if the ore be carefully selected. We have stated above that our first sample of this zinc was free from arsenic, but that the second sample was not pure in this respect. At these works the oxyd of zinc is manufactured, as well as the metal, and we learn from a letter addressed to Professor Brush by Mr. Wharton, the director of the works, that the crust from the oxyd furnaces has now and then been worked into spelter, and that the ore used in making the oxyd is less carefully selected than that which goes to the spelter furnaces, and is much more likely than the latter to contain both blende and pyrites. This fact may account for the occurrence of arsenic in some specimens of this spelter, while the greater part of it, manufactured from carefully selected silicate of zinc, is perfectly free from that impurity. There seems to be no reason why zinc of uniform purity should not be obtained from this excellent ore.*

Pure Zinc.—We have already referred to the difficulty of obtaining a pure zinc by reducing it from the oxyd on a small scale; nothing but the direst necessity could induce us to again attempt the operation, although it has been recommended by many high authorities. Nevertheless it is by no means difficult to prepare a pure oxyd of zinc, and manufacturers of pure chemicals, working on a larger scale than it is practicable for the chemist to do, might undoubtedly prepare from this oxyd at moderate cost a really pure zinc. There are some processes of chemical analysis in which the contamination of zinc with metallic lead is a matter of importance, because it affects the accuracy of the results; but in these cases the difficulty can generally be avoided by discarding zinc altogether, and resorting to other methods of analysis. But in order to use Marsh's process for the detection of arsenic, the chemist must procure zinc free from arsenic, and there is no escape from this necessity; redistillation will not disembarrass zinc of its arsenic, and the process of reducing zinc from a pure oxyd is very laborious and uncertain; how then can zinc free from arsenic be obtained? There is but one satisfactory answer to this question. Pure zinc might certainly be made from the oxyd by the manufacturing chemist, but at present the zinc labelled "pure" by those who sell chemicals is not to be relied upon, and the chemist must therefore test samples procured from the dealer in metals, until he finds a specimen of the pure zinc which is manufactured on a large scale, and is to be obtained in commerce.

* Since this paper was written, Mr. Wharton, director of the Bethlehem Zinc Works has prepared a large quantity of chemically pure zinc for chemical use, in ingots of about ten pounds weight. See his advertisement in this Journal.—Eds.

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ART. XLIV.—*The Gold of Nova Scotia;* by O. C. MARSH, A. B., of the Sheffield Scientific School, Yale College.

ON the Atlantic coast of Nova Scotia is a belt of metamorphic rocks extending the whole length of the Province and varying in width from ten to fifty miles. It is mainly composed of clay slate and quartzite, but in some parts of the district these are replaced by mica slate, gneiss and granite. These strata have a general N.E. and S.W. course and are highly inclined. They have received but little attention from geologists and as no fossils have yet been found in them their exact age has been a matter of considerable uncertainty. Prof. J. W. Dawson, who from his study of this region is best qualified to express an opinion on this point, states that they are probably Lower Silurian, and possibly of the same age as the Potsdam sandstone.*

The general resemblance of these strata to the gold-bearing rocks in other parts of the world had occasionally been noticed, and various explorations for the precious metals had from time to time been made in their vicinity, but I cannot ascertain that gold was actually discovered in this Province earlier than March, 1860, although reports to that effect have been circulated. It was then accidentally found in Halifax county, about fifteen miles from the coast, in the bed of a small stream which empties into the Tangier river. Gold was soon after observed in the adjacent quartz veins also, and in a short time several hundred persons were attracted thither by the reports of the discovery and commenced explorations. The quantity of the gold obtained, however, was so small, that the excitement soon diminished, and but one company continued work for any length of time. In May of that year, the Provincial Secretary, Hon. Joseph Howe, accompanied by Prof. How of King's College, made an official visit to the locality, and on his return published a report which was very unfavorable to future explorations.

The discovery of gold in the Province, although in small quantity, naturally encouraged a further search, and in March of the present year it was again found, on the coast near Tangier harbor, in sufficient abundance to promise profitable employment for a great number of persons, and since that time a large amount has been obtained from that locality. Within the next three months gold was discovered in the same strata at various other places, the most important of which are Rawdon and Douglass, in Hants county; Gold river, near Chester; and Lawrencetown, a few miles east of Halifax. At the latter place there are indications of an extensive deposit of gold, and an association,

* Supplement to Acadian Geology, page 53.

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organized in London, under the name of the "Nova Scotia Gold Mining Company," has recently purchased a tract of land there, and obtained permission from the government to work it for a term of years. In June last, gold was discovered in a bluff on the coast near Lunenburg, and shortly after the sands on the beach below were found to be unusually rich in this metal. It has also been found quite recently at Lake Thomas, about fifteen miles north of Halifax, and some valuable specimens obtained.

While in Nova Scotia a few weeks since I visited Tangier and Lunenburg, the most important of the above localities, and through the kindness of Mr. S. P. Fairbanks, the Provincial Inspector of Mines, I had an opportunity of examining the gold-bearing strata at these places and in their vicinity. I am also indebted to this gentleman for many interesting facts in regard to the discovery of the gold.

The Tangier mines are situated sixty-seven miles east of Halifax and about half a mile from the coast. Here the out-cropping rocks form a series of low hills, which are covered with a thick growth of spruce and hemlock. The strata which contain the gold consist of clay slate, traversed in various directions by veins of quartz, which is generally very compact. The cellular variety, discolored by oxyd of iron, so commonly found with the gold in California and Australia, appeared to be wanting at this locality. The strata, which are here very much disturbed, had been well exposed in many places by the recent explorations, but the nature of the surrounding country prevented any extensive examination of them. At one point they had a strike of S. 84° E., and a dip of 67° S.

The excavations at Tangier were carefully examined for fossils but without success, as the igneous action to which these rocks have been subjected has probably obliterated all traces of those they once contained. The recent discovery, however, of very perfect fossils, of many new species, near Saint John, New Brunswick, in clay slate which closely resembles this in structure, would seem to indicate that some organic remains may have been preserved in this formation.

The gold at Tangier occurs mainly in the quartz veins, which are in most cases less than a foot in width, but in one instance I noticed it in the argillite near its junction with the quartz. It is disseminated through the matrix in the usual manner,—frequently in isolated particles and masses, and where the quartz is white furnishes specimens of great beauty. One of the largest obtained was prized at three hundred dollars, which was but little above its intrinsic value. Gold has also been found in the soil, and in the bed of a small stream near the mines; but not in sufficient quantity to attract much attention.

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The minerals noticed in association with the gold at this locality were mostly iron pyrites and mispickel. The former appeared to be quite abundant, and, suspecting it to be auriferous, I have examined a specimen and find it contains a considerable quantity of gold. The exact amount was not estimated, but it is sufficient to make its separation profitable if conducted with skill and economy. The mispickel at Tangier is frequently found underlying the gold in the quartz veins, and in some cases enclosing it. Chalcopyrite, magnetite, hematite, and galena, also occur in small quantities.

Among the specimens of gold obtained at Tangier I noticed three isolated crystals, which resembled in general appearance those brought from California. The largest of these was about one third of an inch in diameter. It was a rhombic dodecahedron with its edges slightly beveled, and although its faces were marked with delicate striæ several of them were unusually brilliant. The other two crystals were octahedrons, with dull and somewhat rounded faces. One of these was flattened and also much elongated. The smallest crystal was about two lines in length and quite perfect.

The mines at this locality are on the Government lands, and a 'claim,' thirty by thirty-three feet, is rented at twenty dollars per annum. At the time of my visit in August, about seven hundred men were working 'claims,' and a large amount of gold had been taken from the quartz veins, although in many cases at least one third of what they contained was lost by the rude and unsatisfactory methods employed in its extraction. Two crushing mills, however, were then nearly completed, which, although very unlike, were apparently well adapted to the end in view. One of them was very similar to the *arrastre*, a rude instrument used extensively in the silver mines of Mexico, and found to be very effective.* It consisted, essentially, of two large granite boulders, attached by short ropes to a horizontal beam, on either side of an upright shaft, around which they were drawn by a pair of horses. The quartz was put on a paved floor and kept wet, and was crushed by the boulders as they were dragged over it. The other mill was a small sized quartz-crusher of recent invention.

At Lunenburg, which is about seventy miles west of Halifax and one hundred and thirty from Tangier, the gold also occurs in quartz veins traversing the clay slate, which here forms a high bluff, but it is most abundant in the sands of the adjacent beach. Those who first commenced explorations at this place obtained large quantities of gold with very little labor, and their success soon attracted others from all parts of the Province. This locality is known in the neighborhood as "The Ovens," from some

* Ure's Dictionary of Arts, vol. iii, page 677, London, 1860.

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deep caverns which have been worn in the bluff by the action of the sea. It is this denuding power which has torn the gold from its bed and collected it on the beach. There is some reason to believe that a large amount of gold derived from the same source exists in the bottom of the harbor, as the sea-weed which is washed on shore has occasionally small particles of the precious metal attached to it. This point will probably soon be decided; as a "Dredging Company" has been formed, and in a short time will commence operations.

The strata at this place are similar in appearance and structure to those at Tangier, and seem to have been equally disturbed. At one point near the shore where they were well exposed the strike was S. 80° W., and the dip about 75° N. Quartz veins pass through the slate in many directions, and are generally found to contain gold, especially those running north and south. Several dikes of basaltic trap were also observed, one of which was seven feet in width and appeared to be conformable to the strata. The auriferous sand on the shore rests on the edges of the upturned slate, which has here been worn out into 'pockets' of various sizes, well adapted to retain the gold as it is washed over them. After these cavities have been apparently exhausted, a large amount of fine gold can be obtained, for several feet beneath them, between the thin laminæ of the slate.

Nearly the same minerals which were noticed at Tangier also occur with the gold at this locality. The mispickel is more abundant, and is usually in very perfect octahedral crystals, some of which are twins and highly modified. The large amount of this substance in the sand on the beach, makes the gold washing somewhat difficult, and with the rude apparatus employed much of the fine dust is lost. Mercury has not yet been used in separating the gold either here or at the other localities.*

It is impossible to form any reliable estimate of the amount of gold obtained in Nova Scotia since its discovery there in March last, as in almost every instance the 'claims' have been worked by private individuals who were generally disinclined to give information in regard to their own success. Nor would the amount alone, if ascertained, be a fair criterion by which to judge the value of the gold fields, since they have in most cases been explored by those who have had no previous experience in

* While at Lunenburg I was informed of a circumstance connected with the discovery of the gold which illustrates the utility of even a little scientific knowledge, and the need of its more general diffusion. Some years since a farmer, living in the neighboring town of Chester, thought he had discovered a valuable copper mine on his land, and at a great expense sunk a shaft about eighty feet in depth. Finding little copper to repay his labor, and having exhausted all his means, the work was finally abandoned. In his excavations he had cut through a large quartz vein richly stored with gold, which he had noticed, but supposed to be merely copper pyrites. The present owner works this copper mine for gold.

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searching for gold, and only the rudest methods have been employed in obtaining it. I was informed that gold to the value of $2400 had been taken from one 'claim' at Tangier, $1300 from another, and $480 from a third, although many other 'claims' had yielded little or nothing. I saw in Halifax ingots and specimens of Tangier gold which were valued at about $2000, and at Lunenburg at least $250 worth of fine dust which it was said had been washed from a single 'pocket' on the beach.

I have recently analyzed some specimens of gold which I obtained at Tangier and Lunenburg, and the results are given below. The Tangier specimen was taken from a quartz vein, and is very remarkable for its purity. I find it is surpassed in this respect by the gold from only one other locality, viz., Schabrowski, near Katharinenburg, in Siberia.* The Lunenburg gold was in small particles, washed from the sand on the shore. In preparing for the analyses the gold was boiled in chlorhydric acid, fused twice with borax and hammered, and its specific gravity taken. The quantity employed in each case was between one and two grammes, and the analyses were made according to the method used by Rose in his investigations on the gold of the Ural mountains.†

An analysis of the Tangier gold, specific gravity 18·95, gave,

Gold,	98·13
Silver,	1·76
Copper,	·05
Iron,	*trace.*
	99·94

An analysis of Lunenburg gold, specific gravity 18·37, gave,

Gold,	92·04
Silver,	7·76
Copper,	·11
Iron,	*trace.*
	99·91

In some specimens of auriferous quartz from Lawrencetown, obtained of Mr. R. G. Fraser of Halifax, I found mispickel, iron pyrites, galena, and magnetite, associated with the gold in the same manner as at the other localities. In one instance a crystal of mispickel had a small particle of gold passing directly through its center. The specific gravity of the gold from this place was 18·60, which would indicate a degree of purity between that of the Tangier and Lunenburg specimens. The quantity obtained was not sufficient for satisfactory analyses.

Mr. Fraser informed me that some time since, in company with several others, he made explorations for gold on Sable island, and found a small quantity in the sand of which it is

* Dana's Mineralogy, Fourth ed., page 9.

† Reise nach dem Ural, page 406. Berlin, 1842.

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composed. As this island is more than one hundred miles from the coast, this discovery would appear to indicate that the gold-bearing strata of Nova Scotia extend for a considerable distance beneath the Atlantic ocean.

There is another belt of metamorphic rocks in the northern part of this Province which resembles in many respects that on the Atlantic coast, although it probably belongs to a more recent formation. The Cobequid mountains are in this district, and are mainly composed of talcose and chloritic slates, penetrated by dikes of green-stone, sienite and granite. While passing this range in August last, in company with Mr. W. P. Ketcham of New York, I noticed a close resemblance between these rocks and the auriferous strata which I had just examined at Tangier and Lunenburg. The quartz veins were of similar size and appearance, and contained some of the same minerals which are there associated with the gold. I think it probable that these strata also will be found to contain this metal, although the hasty and imperfect examination, which we then were enabled to make, was not rewarded by its discovery.

A public geological survey of Nova Scotia is much needed, and a considerable part of it could be made with comparatively little labor; as in some parts of the Province the formations are so interesting that they early attracted the attention of scientific men, and have been very carefully studied. The districts, however, in which gold has been discovered, and in which it is likely to be found, have been only casually examined, and a systematic survey would make known their real value and prevent the recent discoveries from proving a misfortune, by impairing more important branches of industry. Now that the monopoly of the "General Mining Association," which has so long obstructed the development of the rich mineral resources of the Province, has been removed, it seems especially desirable that this survey should no longer be delayed. The revenue derived from the rent of 'claims' in the gold fields would probably be more than sufficient to carry on the work and could not well be devoted to a better purpose.

The great extent of metamorphic strata in Nova Scotia, so similar to the gold-bearing rocks in other countries, and the fact that gold has now been found at many widely separated points, would seem to indicate that a new and important source of mineral wealth will soon be added to this already favored Province.

Sheffield Laboratory, Yale College, Oct. 5th, 1861.

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ART. XLV.—*Notice of a Meteorite which fell in Hindostan in* 1857; by J. LANG CASSELS, M.D., Professor of Chemistry, Cleveland Med. Coll., Ohio.

THIS meteorite fell near the small village of Parnallee in the extreme south part of Hindostan, and was obtained and sent to the Western Reserve College, Ohio, by the Rev. H. S. Taylor, a graduate of that Institution, at present connected with the Madura mission. Along with the stone he sent the following account of its fall, &c.

"Two meteoric stones fell on the 28th of February, 1857, from a clear sky, about noon, near the village of Parnallee, where some of our Christian people live. The smaller one weighs 37 pounds, and the larger is three or four times as heavy. The larger fell first, the smaller two or three seconds after, and some two or three miles south of the first one. The larger falling into tenacious and hard earth sunk into the ground but two feet and five inches. It came from the north, making an angle with the vertical of about fifteen degrees.

"The smaller one fell perpendicularly and sunk into the ground two feet eight inches. As no rain had fallen since they fell, I was able, on going there three days ago—April, 1857—to make sure their depth, to see just the impression they left when taken up, and to assure myself by enquiry and observation as to the stones having fallen there. Some children were picking cotton within a few rods of the first when it fell; and two women were standing near the place where the second fell. A cloud of dust was seen to be raised in each case, for the ground was very dry. Before night the larger stone was visited by crowds of persons from the neighboring villages, who commenced worshiping it as the image of their deity which had fallen from heaven."

The noise which these meteorites made while passing through the atmosphere is described as being terrific to all in the vicinity; and Mr. Taylor adds, that it was reported to have been heard some 15 or 20 miles from where they fell.

With much difficulty Mr. Taylor succeeded in obtaining both meteorites from the natives, who closely clung to them with great reverential attachment; but the Madrass government having learned of their fall, claimed them as a matter of right, and they accordingly were taken from him and placed in the Madrass Museum where the larger one still remains. Through the influence of some friends, Mr. Taylor, with commendable zeal and much perseverance, succeeded in regaining the smaller one, which he generously sent to the mineralogical cabinet of his alma mater in Hudson, Ohio.

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This meteoric stone has all the appearances of this class of meteorites; it is coated with the usual black vitrified crust, and although angular in its general outlines, it is more or less rounded on these angles; it has numerous spots on its surface, varying in size from a line to an inch and a half in diameter, with a corresponding varying depth; some of them being a quarter of an inch deep—as is attempted to be shown in the accompanying figure. Internally it is a mottled grey color,



having numerous circular spots of dull white. Throughout its recent surface are numerous brilliant specks of nickel, and distinct crystals of nickeliferous iron with a good deal of iron rust. Olivine and schreibersite can also be identified with a magnifier.

The meteorite is remarkable for the great amount of nickel it contains—nearly 17 per cent, while the iron is about 3 per cent. This metal is not uniformly distributed throughout the mass, as is plain even by an examination of the surface by a magnifier.

The magnet abstracts 21·151 per cent from the powdered stone. Color of the powder olive green. Sp. gr. 3·421—3·464.

An examination of the stone detected the presence of silica, lime, potassa, soda, oxyd of iron, sulphid of iron, oxyd of chromium, oxyd of manganese, iron, nickel, cobalt, copper, sulphur and phosphorus.

[A pisolitic structure is very evident in the stone, spherical masses of meteoric pyrites enclosing often a minute granule of white silicate, and surrounded with a coating of a blackish color and magnetic. A similar pisolitic structure has been noticed in other meteorites, as for example in that of Weston, Conn., (1807, Dec. 14). The mottled character of the fresh fracture, presenting large patches of gray and white contrasted with a darker ground, is strikingly similar in these two stones. Very unlike however is the distribution of the iron which in the Connecticut stone

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exists in nodules of some size, while in the Parnallee stone there is a remarkable absence of particles larger than a pin's head. The surface of the Parnallee stone under a file shows countless points of metallic reflection, the metallic nickel being almost in a spongy state resembling silver reduced from its chlorid by zinc. The mineralogical constituents of this stone are clearly brought out on a polished surface, which then presents a porphyritic appearance.*]

ART. XLVI.—*On an Improvement in the Lenticular Stereoscope;* by Prof. E. EMERSON, Troy University.

THE Lenticular Stereoscope, in its common form, has certain imperfections as an instrument which more or less detract from the pleasure which would otherwise attend its use. Nor are these imperfections of such a character as only to be recognized by adepts in its use; on the contrary, they are well known to almost every one who possesses one of these popular and instructive instruments. The causes of these imperfections are not so generally known. A common result of one fault is the difficulty which is experienced in endeavoring to unite the dissimilar right and left pictures; this is, indeed, sometimes quite impossible, and the observer, after a series of exercises, exceedingly straining to the organ of vision, gives over the effort in despair. Another imperfection is the inability of the instrument to exhibit a steroscopic view of pictures much larger than those ordinarily furnished by the dealers in Europe and America. Negatives including a much larger angle are readily obtained, but the positives taken from them are either reduced in copying, or the negatives are cut down to the size of the ordinary stereoscopic picture, when they are printed by contact; thus, oftentimes, some of the most beautiful details in the view are absolutely sacrificed.

* Prof. Cassel's notice of the Parnallee meteorite has been in our hands for some months. We have taken the liberty to add some details to the mineralogical description, having by the kindness of Prof. Young of Hudson, O., had the opportunity of inspecting the stone now in the Cabinet of the Western Reserve College. Understanding from Prof. J. L. Smith that he was engaged in an analysis of this meteorite, we at once suspended a similar analysis then in hand—believing that a chemist so much in the habit of conducting the chemical examination of meteors would do the subject fuller justice than is possible for one not constantly engaged in similar analyses—always difficult and unsatisfactory. Prof. Smith's results have not been received and we do not feel at liberty longer to withhold Prof. Cassels' paper, which has now a new interest in connection with the remarks of Mr. Haidinger, (see *Meteorology.*)

In a private letter Dir. Haidinger says: "As to the structure of the Parnallee meteor I have compared it with those in our Imperial Cabinet and find that among them all it has the closest resemblance to the meteorite which Piddington of Calcutta discovered among a lot of rocks from Assam in 1846." (See this vol., p. 143.)—S.

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We propose in the present article—1st, to account for these imperfections in the stereoscope, and 2d, to describe a simple modification of the instrument, which will remove them completely.

The difficulty experienced in uniting the right and left pictures of certain stereoscopic slides may be occasioned either by the lenses being improperly mounted; or the pictures being arranged on the slides at improper distances from each other; or because the eyes of one observer are naturally wider apart than those of another, and, therefore, the same instrument fails to afford an equally good view to each. Let us examine, briefly, each of these cases. It sometimes happens that the lenses are so adjusted or cut as to occupy improper positions; as a consequence one of the pictures is thrown a little *higher* than the other. If this defect operated only in a horizontal direction it would not be so serious, as, within certain limits, the eyes can accommodate themselves to a horizontal strain; which accounts for our ability to see certain views after a considerable effort, which at first gave us more or less difficulty. But when the discrepancy is one measured on a perpendicular line, it is much more serious; the eyes are not accustomed to move in this direction independently of each other; so that if the imperfect mounting of the lenses causes a variation on this line of from one to two tenths of an inch it will be almost impossible for the observer to unite the views. An easy method of testing an instrument for this fault is to draw upon a piece of white paper the size of a stereoscopic slide, two series of short lines, each series being 2·6 inches from the other, and the lines in each series being drawn at corresponding distances from each other, thus:



Upon placing this in the stereoscope, and looking at it, if the lines unite instantly with no variation, it proves the absence of this fault; but if, on the contrary, we obtain as a resultant a view of more than four lines, thus:



we may be certain that the lenses are not properly mounted, and will give in usage little or no satisfaction. The instrument, however, may be perfect as to its lenses, and a difficulty still be experienced as to certain pictures or by certain persons. When the imperfection consists of a want of proper relation between the lenses and the slide, it usually results from the complement-

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ary pictures being mounted at too great a distance from each other for the power of the fixed lenses to unite them; but the same result may be the effect of an individual peculiarity in the observer, the eyes being naturally wider apart than is common. The variation in the mounting of stereoscopic pictures is very great. In carefully measuring a lot of nearly three hundred different views, on glass and paper, French, English and American, the actual variation was over an inch between the extremes; some being mounted only 2¼ inches apart, and not a few of them over 3¼ inches from each other. Moreover, as might be expected from the variation in practice, there is considerable difference in opinion, among those who have endeavored to settle this point, as to what should be the standard distance between the right and left pictures. Some say, 'the same distance the eyes are separated,' others '2·6 inches,' and a recent writer, Mr. Shadbolt, in the British Journal of Photography, says—"There being two variable quantities involved, viz: the width between the eyes of different observers, and the lateral displacement of rays by the prisms used, it is necessary to obtain something like an approach to an average of the amount of these inconstant quantities, and after careful consideration of the matter, we fixed it at 2·75 inches." The same writer, however, finds the distance required by Smith and Beck's achromatic stereoscopes very constant at 2·8 inches. It does not seem that there is a clear apprehension of the truth in regard to this point; which is that the distance the pictures should be mounted apart will depend entirely upon the deflecting power of the lenses employed to unite them. And as there does not appear to be any standard for this power of the lenses, there is, consequently, none to regulate the distance the right and left hand pictures should be separated. It is easy to see, therefore, that a stereoscope which will enable us to see, equally well, different views which vary more than an inch in the mounting is a desideratum.

The lenses of the ordinary stereoscope are so mounted that the eyes of the same observer always look through the same portion of each lens, which of course always causes the same amount of deflection, and answer perfectly to unite pictures which are separated from each other a certain, uniform distance. In order to measure this distance for any particular instrument take ten or fifteen pieces of white paper or card-board, the size of a stereoscopic slide, and upon the first, draw two lines one quarter of an inch in length, perpendicular to the lower side of the card, and parallel to each other, thus:



increase the distance between the lines upon each successive card

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one-tenth of an inch until the lines upon the last card are three and one-half inches apart; now look at each of these in the stereoscope with a rather hasty glance, and it will be easy to determine at what distance the lines should be apart to coalesce perfectly and instantly. This will be the distance the centres of the right and left pictures should be separated *for that instrument.*

But further, the ordinary lenticular stereoscope does not permit the view of a picture measuring over three inches from one side to the other; i. e., it affords a view of nine square inches as a maximum.* Sir D. Brewster, in his work on the Stereoscope, pp. 162, 163, declares that—"the *size* of the pictures is determined," "that nothing can be gained by using larger pictures," &c., &c. This is true with regard to the ordinary form of the stereoscope. But this renders it none the less a very desirable thing to be able to see larger pictures: and by larger pictures we do not mean the same pictures magnified, for then, indeed, nothing would be gained, but pictures including a larger angle, and affording a view of more than twenty square inches as a maximum.

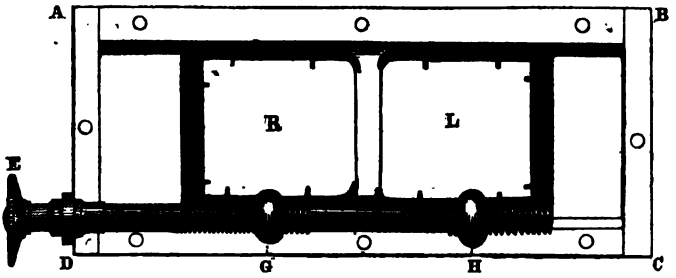
Before proceeding to a description of an improvement which accomplishes this result, it will be necessary briefly to remind the reader that the lenses employed in the stereoscope while they are constant as to their focal length, vary exceedingly as to their power of deflecting a ray, increasing it regularly as we proceed from the centre of the lens to its thin edge; so that pictures which can be easily united when seen through the thicker or central portion of the lenses, require to be separated more and more from each other as we separate the glasses, and thus force the eyes to use a more highly deflecting portion of the lenses. The modification we propose in order to give the instrument a general character, and adapt it to all sorts of views is an adjustment by which the lenses are rendered movable in a horizontal direction, so that they can be readily approached near to each other until the edges touch, or separated from each other as far as the distance between the eyes will allow; i. e. the distance traveled by each lens will be measured by the distance between the thickest and thinnest portions of that lens, which will be a little over an inch. To operate properly the lenses should move simultaneously, at uniform rates and in opposite directions. As the right lens moves towards the right, the left lens moves towards the left, and vice versa. By this means the lenses are made equivalent to prisms with variable angles. An easy method of accomplishing this is shown in the following diagram

* The Reflecting Stereoscope of Wheatstone will exhibit larger pictures, but it is not adapted to popular use.

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exhibiting the *under side* of the lenses and their mechanical attachment.

This apparatus takes the place of the lenses in the various forms of the lenticular stereoscope. We have adjusted our own to a common hand-stereoscope merely flanging the sides so as to afford a view of glass and paper slides measuring ten inches in length by four inches in width.



A B C D, light brass frame in which the lenses slide.

R, right-hand lens. L, left-hand lens.

G, nut attached to the setting of the right lens through which a right-hand screw turns.

H, nut attached to the setting of the left lens, through which a left-hand screw turns.

E, Milled head on the end of the rod upon which is cut the right-hand screw for the nut G and also the left-hand screw for the nut H.

By turning the milled head E the lenses either advance towards each other or recede from each other as may be desired.

By means of this instrument, whatever the distance between the eyes, pictures may be easily and perfectly united which are mounted at any distance apart between two, and four and a half, inches from centre to centre; and this, too, with the ordinary stereoscopic lenses; if achromatic lenses are used, it is quite practicable to unite pictures which measure five inches from centre to centre, affording a view filling twenty square inches, which is considerably more than twice as large as the ordinary slides.

Troy University, Oct., 1861.

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SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.—

1. *Photographs of Spectra exhibited to the Chemical Section of the British Association;* by Prof. W. A. MILLER (Chairman). He remarked:—The apparatus by which the spectra may be photographed consists of an ordinary camera obscura attached to the end of a long wooden tube, which opens into a cylindrical box, within which is a prism glass, or a hollow prism filled with bisulphid of carbon. If the prism be so adjusted as to throw the solar rays, reflected from a heliostat, upon the screen of the camera, and the wires which transmit the sparks from a Ruhmkorff coil are placed in front of the uncovered portion of the slit, the two spectra are simultaneously impressed. The solar beam is easily intercepted at the proper time by means of a small screen, and the electric spectrum is allowed to continue its action for two or three, or six minutes, as may be necessary. He did not find that anything was gained in distinctness by interposing a lens of short focus between the slit and the wire which supplied the sparks, with the view of rendering the rays of the electric light parallel like those of the sun, owing to the absorbent action of the glass weakening the photographic effect; and the flickering motion of the sparks being magnified by the lens, rendered the lines less distinct than when the lens was not used. Although with each of the metals (including platinum, gold, silver, copper, zinc, aluminium, magnesium, iron), when the spark was taken in air, he obtained decided photographs, it appeared that in each case the impressed spectrum was very nearly the same, proving that few of the lines produced were those which were characteristic of the metal. The peculiar lines of the metal seemed chiefly to be confined to the visible portion of the spectrum, and these had little or no photographic power. This was singularly exemplified by repeating the experiment upon the same metal in air, and in a continuous current of pure hydrogen. Iron, for example, gave, in hydrogen, a spectrum in which a bright orange and a strong green band were visible, besides a few faint lines in the blue part of the spectrum. Although the light produced by the action of the coil was allowed to fall for ten minutes upon a sensitive collodion surface, scarcely a trace of any action was procured; whilst, in five minutes, in the air, a powerful impression of numerous bands was obtained. It is remarked by Mr. Talbot that, in the spectra of colored flames, the nature of the acid did not influence the position of the bright lines of the spectrum, which he found was dependent upon the metal employed, and this remark had been confirmed by all subsequent observers. But the case was very different in the absorptive bands produced by the vapors of colored bodies,—there the nature of both constituents of the compound was essentially connected with the production of absorptive bands. Chlorine, combined with hydrogen, gave no bands by absorption in any moderate thickness. Chlorous acid and peroxyd of chlorine both produced the same set of bands, while hypochlorous acid, although a strongly colored vapor and containing the same elements, oxygen and chlorine, produced no absorptive bands.

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Again, the brownish red vapor of perchlorid of iron produced no absorptive bands; but when converted into vapor in a flame this gave out bands independent of the form in which it occurred combined. These anomalies appeared to admit of an easy explanation on the supposition that, in any case, the compound is decomposed in flame, either simply by the high temperature, just as water is, as shown by Grove, or, in all other cases of the production of bright lines by the introduction of a metallic salt into a flame of burning bodies (as shown by Deville). In the voltaic pile the decomposition must of necessity take place by electric action. The compound gases, protoxyd and binoxyd of nitrogen, gave, when electrified, the same series of bright bands (as Plücker had shown) which their constituents when combined furnish. Aqueous vapor always gives the bright lines due to hydrogen and hydrochloric acid, the mixed system of lines, which could not be produced by hydrogen and chlorine. The reducing influence of the hydrogen and other combustible constituents of the burning body would decompose the salt, liberating the metal, which would immediately become oxydized or carried off in the ascending current. There was obviously a marked difference between the effect of intense ignition upon most of the metallic and the non-metallic bodies. The observations of Plücker upon the spectra of iodine, bromine and chlorine show that they give, when ignited, a very different series of bands to those which they furnished by absorption, as Dr. Gladstone had already pointed out; but it was interesting to remark that, in the case of hydrogen, which, chemically, was so similar to a metal, we have a comparatively simple spectrum, in which the three principal bright lines correspond to Fraunhofer's dark lines, C, F, and G. It was, however, to be specially noted that the hydrogen occasioned no perceptible absorptive bands at ordinary temperatures in such thickness as we could command in our experiments, and the vapor of boiling mercury was also destitute of any absorptive action, although when ignited by the electric spark it gave a characteristic and brilliant series of dark bands. The following experiment suggested itself as a direct test of Kirchhoff's theory. Two gas-burners, into which were introduced chlorid of sodium on the wick of the spirit lamp, were placed so as to illuminate equally the opposite sides of a sheet of paper partially greased. The rays of the electric light screened from the photometric surface, suitably protected, were made to traverse one of the flames. If the yellow rays of light were absorbed by the sodium flame, the light emitted laterally by the flame should be sensibly increased. The experiment, however, failed to indicate any such increase in the brilliancy of the flame, possibly because the eye was not sufficiently sensitive to detect the slight difference which was to be expected.—*Athenæum*, Sept. 14, 1861.

CHEMISTRY.—

2. *On Cæsium and Rubidium.*—BUNSEN has communicated a preliminary notice of the two new metals discovered by Kirchhoff and himself by means of the spectral analysis. Both of these metals exhibit in their compounds an extraordinary resemblance to potassium, and cannot be distinguished from it either by reagents or by the blowpipe. The first of the new metals is named Rubidium from *Rubidus*, dark red, referring to two very remarkable spectral lines, which lie beyond Fraunhofer's line A,

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and consequently occur in a portion of the spectrum which can only be rendered visible by unusual methods. The authors have found the metal in the greatest quantity in the lepidolites; that of Rozena, in Moravia, contains about $\frac{2}{1000}$ of its weight of oxyd of rubidium — the Saxon lepidolite appears to be still richer. Traces of it are found in almost all mineral waters, but it does not appear to be always present in the potash compounds of commerce. The compounds of Rubidium are most easily obtained pure from lepidolite. The rubidium is contained with small portions of Cæsium in the precipitate of chlorplatinate of potassium obtained from the mineral. The chlorplatinate of potassium requires nineteen times, the chlorplatinate of rubidium one hundred and fifty-eight times its weight of boiling water for solution. The precipitate is to be boiled repeatedly with very little water, and the solution each time simply poured off from the precipitate, which exhibits in the spectral apparatus, after a few boilings, two new blue lines which lie close to the blue calcium line, which the authors have not represented in their first plate of the spectrum, because it is one of the weaker lines; by further treatment with water, the two red lines beyond *A*, soon appear, together with several others which are less characteristic. The chlorid of rubidium is easily obtained from the precipitate by reduction with hydrogen and extraction with water. In this manner the authors obtain from 150 kilogrammes of lepidolite, about two ounces of nearly pure rubidium salt. By repeating the process of precipitation with chlorid of platinum and boiling several times, the last traces of potassium may be removed. To obtain rubidium free from cæsium, the salt must be converted into carbonate and repeatedly extracted with alcohol, which dissolves the carbonate of cæsium.

Rubidium forms with mercury, with the aid of the Voltaic circuit, an amalgam of silver-white color and crystalline structure. This amalgam quickly oxydizes in the air, decomposes water in the cold and is electropositive to potassium. The equivalent of rubidium is 85·36 and its symbol Rb.

The hydrate RbO, HO+aq is soluble in almost all proportions in water and alcohol; gives off its water of crystallization by heating, leaving RbO, HO which on farther heating, melts but does not lose its atom of water, is caustic like potash, dissolves in water with strong evolution of heat, and greedily attracts water and carbonic acid from the air.

The carbonate RbO, CO_2 forms indistinct strongly alkaline crystals, insoluble in alcohol, and leaving on heating RbO, CO_2+aq as a sandy powder, which melts easily, deliquesces and absorbs an additional atom of carbonic acid. The bi-carbonate RbO, CO_2+HO, CO_2 forms prismatic crystals permanent in the air, with a faint alkaline reaction, and a cooling, not caustic taste. The nitrate RbO, NO_5 is not rhombic like saltpetre but crystallizes in dihexagonal prisms, with less distinctly formed twelve sided pyramids. The sulphate forms large hard anhydrous crystals, having a glassy lustre and permanent in the air: they are isomorphous with sulphate of potash. This sulphate gives with sulphate of alumina an alum crystallizing in hard glassy octahedra, and with sulphate of cobalt a beautiful double salt isomorphous with KO, SO_3+CoO, SO_3 +6HO. The chlorid RbCl is anhydrous, permanent in air, crystallizing with difficulty in cubes, easily fusible, and readily and completely

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volatile on the platinum wire. The chlorplatinate $RbCl, PtCl_2$ is a bright yellow, anhydrous, sandy powder, consisting of microscopic regular octahedra, which can only be distinguished from the chlorplatinate of potassium by its lesser solubility.

The second of the new elements, the authors term Cæsium, from *Cæsius*, sky blue; it gives a beautiful and highly characteristic spectral line, lying near the strontium-line *Sr*δ. It appears to constantly accompany rubidium, but occurs for the most part in small quantity. Ten kilogrammes of the Dürkheimer water contain not quite two milligrammes of chlorid of cæsium. The authors obtained it from this water. The potassium, rubidium and cæsium are precipitated together by chlorid of platinum, and the double chlorids of potassium and rubidium, separated as much as possible by boiling with water; the cæsium may then be extracted by converting the mixed chlorids into carbonates, and dissolving out the carbonate of cæsium with absolute alcohol. To remove the last traces of potassium and rubidium, about $\frac{1}{5}$ths of the carbonate are rendered caustic by baryta water, the mass evaporated in a silver dish, and the caustic oxyd of cæsium dissolved out with absolute alcohol, which leaves the carbonates of potassium and rubidium. This operation must be repeated till the spectral analysis exhibits at most a very faint reaction for potassium and rubidium.

The amalgam of cæsium decomposes water in the cold and oxydizes in the air: it is electro-positive to both potassium and rubidium, and is therefore the most electro-positive of all known elements. The equivalent of cæsium is 123·4 and its symbol Cs.

The hydrate $CsO, HO + aq$ is indistinctly crystallized, deliquescent and extremely caustic; it loses an atom of water by ignition, evaporates completely when heated in the flame and is easily soluble in alcohol. The carbonate forms indistinct crystals, soluble in five times their weight of absolute alcohol, deliquescent and very caustic. The bicarbonate forms permanent, glassy prismatic crystals. The nitrate is anhydrous and isomorphous with nitrate of rubidium. The sulphate is also anhydrous and permanent in air; it forms a well crystallized alum and double sulphates isomorphous with $KO, SO_3 + MgO, SO_3 + 6HO$. The chlorid crystallizes in cubes and is deliquescent in the air; it is slightly volatile and easily becomes somewhat basic, when heated in air. The chlorplatinate forms bright yellow microscopic regular octahedra, and is the least soluble of the three alkaline double chlorids.—*Ann. der Chemie und Pharmacie*, cxix, 107.

3. *Probable existence of a new Element.*—Crookes has proposed the name Thalium for what appears to be a new element existing in certain seleniferous and telluriferous deposits produced in the manufacture of sulphuric acid. The new element appears to belong to the oxygen and sulphur group, and produces in the spectrum an extremely pure and vivid green line comparable in intensity with the sodium line D. Thalium (*θαλλος*) was not detected in seleniferous and telluriferous minerals hitherto examined, but two or three specimens of native sulphur, among others those from Lipari, contain a small quantity, so that the sulphur of this locality may prove an available source of the substance in question. Thallium appears to be a dense brown powder characterized in a very re-

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markable manner by the spectral line referred to. Its physical and chemical properties are not yet described.—*Chemical News, May*, 1861.

[The name Thalium is preoccupied, having been proposed by Dr. D. D. Owen (this Journal, [2], xiii, 420, 1852) for a supposed new metal found by him in *Thalite*, a greenish hydrous silicate from the north shore of Lake Superior.—Eds.]

4. *Reduction of Sulphuric Acid by Nascent Hydrogen.*—Kolbe has observed that sulphydric acid gas is always set free in perceptible quantity by the action of concentrated sulphuric acid upon metallic zinc. When the sulphuric acid is previously diluted with twice its volume of water perfectly pure hydrogen is obtained; the addition of concentrated acid immediately produced the odor of sulphydric acid. The hotter the liquid and the stronger the acid, the greater will be the quantity of sulphydric acid produced. Kolbe remarks that this fact is important in judicial investigations, since if concentrated sulphuric acid be used in Marsh's apparatus a part or perhaps the whole of the arsenic present might be converted into sulphid and thus escape detection.—*Zeitschrift für Chemie*, iv, *Jahrgang*, 419.

5. *On certain Organic Acids.*—Malic acid by the action of heat yields, as is well known, fumaric and maleic acids. Perkin and Duppa and Kekulè have shown that malic and tartaric acids may be prepared from succinic acid, and Kekulè now finds that fumaric and maleic acids may be readily converted into succinic acid or a derivative of this. When fumaric acid is heated for a few minutes in a water-bath with bromine and water, the bromine disappears, and on cooling white crystals of bibromosuccinic acid separate. The reaction is represented by the equation

$$C_8H_4O_8 + 2Br = C_8H_4Br_2O_8,$$

and consists not in a substitution but in a simple *addition* of bromine.

By the action of nascent hydrogen upon fumaric acid, succinic acid may be directly produced, a simple addition of H_2 taking place. Kekulè calls attention to the fact that this made of formation by *addition* has hitherto been unobserved in the case of the organic acids, and only rarely in the case of other organic bodies.

Maleic acid in like manner forms bibromosuccinic acid by the action of bromine, but another acid is formed at the same time which has not yet been studied. Maleic acid also combines with nascent hydrogen to form succinic acid. Iodhydric and bromhydric acids convert maleic into fumaric acid. Kekulè points out the following interesting parallels.

Succinic acid,	$C_8H_6O_8 - H_2 = C_8H_4O_8$, Fumaric acid.
Propyl alcohol,	$C_6H_8O_2 - H_2 = C_6H_6O_2$, Allyl-alcohol.
Propyl aldehyd,	$C_6H_6O_2 - H_2 = C_6H_4O_2$, Acrolein.
Propionic acid,	$C_6H_6O_4 - H_2 = C_6H_4O_4$, Acrylic acid.
Stearic acid,	$C_{36}H_{36}O_4 - H_2 = C_{36}H_{34}O_4$, Oleic acid.
Marsh gas,	$C_4H_6 - H_2 = C_4H_4$, Olefiant gas.
Alcohol,	$C_4H_6O_2 - 2HO = C_4H_4$, " "
Malic acid,	$C_8H_6O_{10} - 2HO = C_8H_4O_8$, Fumaric acid.
Ethylene,	$C_4H_4 + 2Br = C_4H_4.Br_2$, Bromid of ethylene.
Fumaric acid,	$C_8H_4O_8 + 2Br = C_8H_4Br_2O_8$, Bibromsuccinic acid.
Ethylene,	$C_4H_4 + BrH = C_4H_5Br$, Bromid of ethyl.
Fumaric acid,	$C_8H_4O_8 + BrH = C_8H_5BrO_8$, Monobromsuccinic acid.

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Ethylene, $C_4H_4 + H_2 = C_4H_6$, Marsh gas.
Fumaric acid, $C_8H_4O_8 + H_2 = C_8H_6O_8$, Succinic acid.
Ethylene, $C_4H_4 + 2HO_2 = C_4H_6O_4$, Glycol.
Fumaric acid, $C_8H_4O_8 + 2HO_2 = C_8H_6O_{12}$, Tartaric acid.

The analogy in these reactions cannot be doubted; the difference in properties and functions is easily explained by the fact that some of the substances contain oxygen, others none. More interesting and suggestive relations have seldom been brought forward.—*Ann. der Chemie und Pharmacie*, i, Supplement, Band 1, p. 129.

6. *Mathematical Theory of Homologous Series.*—Bacologlo has given an interesting mathematical development of the theory of homologous series considering the properties of bodies as functions of their constitution. Consider $C\alpha H\beta O\gamma$ as representing a single term of such a series; the properties of this body are functions of the qualitative and quantitative character of the forces which determine the equilibrium of the compound. These forces reside in the elements C, H, O and are more or less active according to the number of equivalents of each. If U be any property of the body $C\alpha H\beta O\gamma$, F an arbitrary function, a, b, and c the molecular forces or states of the elements C, H, O and α, β, γ the number of equivalents of each, we shall have:—

$$U = F(a, \alpha;\ b, \beta;\ c, \gamma)$$

For a second body $C\alpha+\Delta\alpha\ H b+\Delta\beta\ O\gamma$ differing from the first only in the number of equivalents of C and H, containing therefore $\Delta\alpha$ carbon and $\Delta\beta$ hydrogen more or less, the corresponding property will have another value U_1 and we shall have

$$U_1 = F(a, \alpha+\Delta\alpha;\ b, \beta+\Delta\beta;\ c, \gamma)$$

It remains to determine the connection between U and U_1. Since a, b, c and γ are constants we may obviously write

$$U = F(\alpha, \beta)$$
$$U_1 = F(\alpha+\Delta\alpha, \beta+\Delta\beta)$$

whence by Taylor's theorem,

$$F(\alpha+\Delta\alpha, \beta+\Delta\beta) = F(\alpha, \beta)+\Delta\alpha\frac{d}{d\alpha}F(\alpha, \beta)+\Delta\beta\frac{d}{d\beta}F(\alpha, \beta)+$$
$$\frac{\Delta\alpha^2}{2}\frac{d^2}{d\alpha^2}F(\alpha, \beta)+\Delta\alpha\Delta\beta\frac{d^2}{d\alpha d\beta}F(\alpha, \beta)+\frac{\Delta\beta^2}{2}\frac{d^2}{d\beta^2}F(\alpha, \beta)+ \&c.$$

Or,

$$(3.)\quad U_1 = U+\Delta\alpha\frac{dU}{d\alpha}+\Delta\beta\frac{dU}{d\beta}+\frac{\Delta\alpha^2}{2}\frac{d^2U}{d\alpha^2}+\Delta\alpha\Delta\beta\frac{d^2U}{d\alpha d\beta}+\frac{\Delta\beta^2}{2}\frac{d^2U}{d\beta^2}+ \&c.$$

In homologous series $\Delta\alpha = \Delta\beta$ and we may write Δ for the increase in the number of equivalents of carbon and hydrogen, hence (3) becomes

$$(4.)\quad U_1 = U+\Delta\left\{\frac{dU}{d\alpha}+\frac{dU}{d\beta}\right\}+\frac{\Delta^2}{2}\left\{\frac{d^2U}{d\alpha^2}+2\frac{d^2U}{d\alpha d\beta}+\frac{d^2U}{d\beta^2}\right\}+ \&c.$$

whence for D the difference in the properties of the two bodies,

$$(5.)\quad D = U_1 - U = \Delta\left\{\frac{dU}{d\alpha}+\frac{dU}{d\beta}\right\}+\frac{\Delta^2}{2}\left\{\frac{d^2U}{d\alpha^2}+2\frac{d^2U}{d\alpha d\beta}+\frac{d^2U}{d\beta^2}\right\}+ \&c.$$

The first differential co-efficients $\frac{dU}{d\alpha}$, $\frac{dU}{d\beta}$, express the rate at which the

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property U varies with the increase of α and β; they express the quantity of the variation and may therefore be considered as constant. The second and higher differential coefficients consequently vanish and we have

$$D = U_1 - U = \Delta \left\{ \frac{dU}{d\alpha} + \frac{dU}{d\beta} \right\} \qquad (6.)$$

$$\text{and if } k \text{ be a constant} = \frac{dU}{d\alpha} + \frac{dU}{d\beta} \qquad (7.)$$

$$D = U_1 - U = k\Delta \qquad (8.)$$

from which it follows that the difference D of the properties U_1 and U of two homologous bodies is proportional to the difference of their chemical constitution.

The complete law of the variation of the properties of homologous bodies is given by equation (5) and if we write S for the sum of the terms containing higher powers of Δ we shall have

$$D = U_1 - U = k\Delta + S.$$

from which it follows that strictly speaking the difference of properties is not directly proportional to the difference of chemical constitution but is more nearly proportional the smaller the influence of the term S. This explains small deviations from the exact law in the case of boiling points, &c. The factor k will in general not be identical in the case of different homologous series. Thus in the series

$$C_4H_4Br_2$$
$$C_6H_6Br_2$$
$$C_8H_8Br_2$$

the property V is a function of the molecular states a, b, c and the numbers α, β, γ of the elements C, H, Br

$$V = \Phi(a, \alpha;\ b, \beta;\ c, \gamma)$$

the function Φ being different from F because the molecular force e differs from the molecular force c. Hence we shall have

$$D' = V_1 - V = \Delta \left\{ \frac{dV}{d\alpha} + \frac{dV}{d\beta} \right\} + S'$$

or (10)
$$D' = V_1 - V = k'\Delta + S'$$

so that in this series also the difference in properties will be nearly proportional to the difference in constitution but will not be identical with the difference in the case of the first series, the modulus k' being different from k. This explains the variation in uniformity exhibited in Kopp's laws of serial differences. The author proposes to continue his investigations in the same direction. They amount, as it seems to the reviewer, to a somewhat elaborate though easy mathematical proof of that which can be shown to be necessarily true by much simpler reasoning.—*Journal für prakt. Chemie*, lxxxiii, p. 494.

7. *On the Conversion of Monobromid of Ethylene into Acetylene.*—Sawitch finds that the bromid $C_4H_3Br.Br_2$ when decomposed by an alcoholic solution of potash, gives bibromid of ethylene, which is always accompanied by a small quantity of other substances. When the vapors evolved during the reaction are conducted into an ammoniacal solution of suboxyd of copper, a dark red flocky precipitate is produced which,

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on drying, detonates violently when heated or struck. This substance is identical with the red compound which acetylene forms with copper, whence it appears that acetylene is a product of the decomposition of bromid of ethylene, by an alcoholic solution of potash. It appears probable that a portion of the monobromid of Ethylene which occurs in this reaction loses an equivalent of bromid of hydrogen, and is converted into acetylene. The following equations will explain this reaction:

$$C_4H_4Br_2+KO,HO=C_4H_3Br+KBr+2HO$$
$$C_4H_3Br+KO,HO=C_4H_2+KBr+2HO$$

When monobromid of ethylene is heated with amylate of sodium, bromid of sodium, amylic alcohol, and acetylene are produced. The equation is

$$C_4H_3Br+\left.\begin{matrix}C_{10}H_{11}\\Na\end{matrix}\right\}O_2=\left.\begin{matrix}C_{10}H_{11}\\H\end{matrix}\right\}O_2+NaBr+C_4H_2$$

Sawitch has since found that the same reaction serves to form the homologues of acetylene—thus monobromid of propylene by the action of ethylate of sodium produces a new hydrocarbon, which the author terms allylene, and which has the formula C_6H_4. Allylene forms with copper solutions, a voluminous flocky yellow precipitate, which on heating burns quickly with a reddish flame; bromine decomposes it with effervescence and production of red flames; with concentrated acids it gives off gas even in the cold. Allylene is colorless; has a strong and disagreeable smell; burns with a bright and very smoky flame and precipitates solutions of silver and nitrate of suboxyd of mercury. Allylene combines with bromine to form a clear and colorless liquid which is probably $C_6H_4Br_2$. The author promises a more extended investigation.—*Journal für prakt. Chemie*, lxxxiii, p. 240 and *Comptes Rendus*, lii, 157 and 399.

8. *On the Reproduction of certain Crystalline Minerals.*—H. Saint Claire Deville has succeeded in preparing a number of crystalline metallic oxyds by the action of a current of chlorhydric acid gas upon metallic oxyds heated in a platinum boat contained in a tube of porcelain. The temperature usually employed was that of melting copper. A volatile chlorid is at first produced and this is then decomposed by the vapor of water formed in the reaction, the temperatures of formation and decomposition being probably different. In this manner the author obtains stannic acid, SnO_2, in beautiful crystals of the same form as the native oxyd. Titanic acid forms brilliant crystals of a bluish tint like anatase. A mixture of chlorhydric acid gas and a reducing agent (hydrogen?) gave small crystals of a new saline oxyd having the formula TiO_2, Ti_2O_3 or Ti_3O_5, which is perhaps the true formula of anatase. Crystallized rutile is also formed by heating together to redness titanic acid and protoxyd of tin and then heating this mass with a silica to a cherry red heat. The crystals contain a small quantity of stannic acid. Deville finds vanadium in many rutiles; that of St. Yrieux is one of the richest ores of this metal. The author has prepared by the chlorhydric acid process magnetite in regular octahedra; magnoferrite Fe_2O_3, MgO in octahedra; periclase in colorless or greenish octahedra; hausmanite in square octahedra; protoxyd of manganese in beautiful emerald green octahedra or cubo-octahedra; specular iron in beautiful crystals like the Elba ore. In the last case the current of gas must be slow and regular otherwise the

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sesquioxyd of iron is entirely converted in sesquichlorid. Deville suggests that gaseous emanations, as for example chlorhydric acid, may play an important part in geological phenomena and may conduce to the formation of many crystalline minerals.—*Comptes Rendus*, lii, 1264, liii, 161, 199.

W. G.

9. *On a new characteristic of the so-called Semi-Metals;* by Prof. JEROME NICKLÈS. (Communicated by the author.)—The so-called semi-metals stand between the metals and metalloids marking the transition between these two classes of elements. They share with the first: 1. The metallic lustre; 2. Conductivity of heat; 3. Conductivity for electricity; 4. Density.

With the metalloids they possess the property; 1. of being acidifiable; 2. of forming only feeble salifiable bases; 3. of combining easily with the metals in the manner of an electro-negative body; 4. some of them form a gaseous compound with hydrogen.

These characters are not absolute, and under them the semi-metals may vary among themselves as much as they differ from other elements—but notice a consideration which enables us to determine nearly where the series of semi-metals begins and ends.

The idea of *malleability* is the one which attaches itself most forcibly to our notice of a metal. The word metal involuntarily recalls a body sonorous, heavy, capable of being hammered and drawn into leaves and wire or extended in the rolls.

Viewed from this side we find certain of the metallic elements which possess neither malleability or ductility, and strangely enough these elements are those which we know as *acidifiable metals*. Among them we find *tellurium*, *tungsten*, *osmium*, *arsenic*, *antimony* and lastly, *bismuth*, which only lately passed among the metals, but which has lately fallen from that rank since the establishment of its isomorphism with antimony and arsenic—themselves isomorphous with phosphorus and nitrogen.—[*Comptes Rendus de l'Acad. des Sci.*, T. L, p. 872, and T. LI, p. 1097. 1860.]

Bismuth has in fact all the external characters of the metals, saving in its want of tenacity and its brittleness, peculiarities common to all the other elements of a metallic lustre which we call semi-metals.

Wanting tenacity, these elements ought consequently to possess little elasticity and sonorousness; but these characters are less obvious and require experiments to determine them, while it is easy to recognize the character of brittleness and want of tenacity.

We propose therefore to consider as *semi-metals* those metallic elements which are neither ductile or malleable, in other words, the *brittle metals*.

Nancy, 23d August, 1861.

TECHNICAL CHEMISTRY.—

10. *On the Coloring Matters Derived from Coal-Tar;* by Mr. H. W. PERKIN, F.C.S. (A lecture delivered before the [London] Chemical Society on Thursday, May 16, 1861); from the [London] Journal of Gas Lighting, etc., p. 483, July 2, 1861.—Continued from p. 274.

Bleu de Paris.—This is yet another coloring matter produced under circumstances similar to those which give rise to fuchsine. MM. Persoz, V. de Luynes, and Salvétat, give the following account of its preparation and properties:—"Nine grammes of bichlorid of tin and 16 grammes of

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aniline, heated for thirty hours to a temperature of about 180 centigrade, in a sealed tube, produce neither a red nor a violet, but a very pure and lively blue. This blue, which resists acids, darkens in color by alkalies, but passes to a groselle violet when submitted to this agent in a concentrated state. It preserves its beauty of color by artificial light, and it dyes animal fibres of a shade whose beauty leaves nothing to be desired." I repeated the above experiment twice, and was inclined to give up in despair, for, instead of a fine blue, I obtained nothing more than a dirty-green product. But, from this unpromising product, I at last succeeded in obtaining this beautiful blue coloring matter, and found it to possess all the properties mentioned above. MM. Persoz, V. de Luynes, and Salvétat, have lately given a more particular account of this coloring matter. They describe it as crystallizing from the alcohol solution in the form of fine needles, having an aspect similar to that of ammoniacal sulphate of copper. It is soluble in water, alcohol, wood-spirit, and acetic acid; but insoluble in ether and bisulphid of carbon. With concentrated sulphuric acid, it forms an amber-colored solution, which water converts into a magnificent blue liquid. Strong nitric acid decomposes it; chromic acid precipitates it from its aqueous solutions without decomposition; chlorine destroys it; sulphurous acid does not decolorize it. I found that sulphid or ammonium is also without action upon it. It is precipitated from its aqueous solutions by alkalies and saline compounds.

Aniline Green, or Emeraldine.—Most chemists who have worked with aniline in the laboratory must have noticed the peculiar green-colored substance which forms on the outside of the various species of chemical apparatus that have been standing in the vicinity of any quantity of this body. This product is aniline green. Aniline green has been known for several years. It may be formed by various processes. One process consists in oxydizing aniline with chloric acid. This is effected by mixing a hydrochloric acid solution of aniline with chlorate of potassa. It may also be obtained by oxydizing a salt of aniline with perchlorid of iron. Obtained by either of these processes, it presents itself as a dull green precipitate which, when dried, assumes an olive-green color. It is insoluble in water, alcohol, ether, and benzole; sulphuric acid dissolves it, forming a dirty purple-colored solution from which it is precipitated unchanged by water. With alkaline solutions, it changes to a deep color somewhat similar to indigo: but acids restore it to its original color. The color of aniline green is much enlivened by the presence of an excess of acid; but, unfortunately, as soon as this acid is removed, it passes back to its normal color.

The bases tolzidine, xylidine, and cumidine yield coloring matters under the influence of oxydizing agents; and also when submitted to the action of reducible chlorids at high temperatures, analogous to those obtained from aniline under similar circumstances; but the results generally are not so good, the color of the products becoming tinged with brown as the bases get higher in the series.

Nitroso-Phenyline.—This remarkable body is obtained by the action of nascent hydrogen on an alcoholic solution of di-nitro-benzole. It is represented by the formula $C_6H_6N_2O$. This body is almost insoluble in water, but soluble in acids, and in alcohol, producing crimson-colored

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solutions, but its color is not nearly so brilliant as that of fuchsine. It seems gradually to decompose when kept. I have not tried any experiments with it as regards its dyeing properties.

Dinitraniline.—Dinitraniline is obtained by decomposing dinitro-phenyle citraconamide by means of carbonate of soda. When pure, it crystallizes in yellow tables. It dissolves very sparingly in water, producing a yellow liquid. It has the formula $C_6H_5(NO_2)N_2$. It does not combine with acids or alkalies, although it appears to be more soluble in acidulated than in pure water. Silk can be dyed yellow with dinitraniline.

Nitrophenyline-diamine, or Nitrazophenalimine.—Dinitraniline, when submitted to the action of sulphid of ammonium, changes into this beautiful base, which crystallizes in needles of a red color, somewhat similar in appearance to chromic acid. It dissolves in water, forming a yellow or orange-colored solution like that of bichromate of potassa. Alcohol and ether dissolve it freely. It is not at all similar to fuchsine in its properties, as it forms salts of yellowish brown or grey color; whereas, fuchsine forms crimson ones. I mention this because nitrophenylene-diamine has been spoken of as having properties similar to those of fuchsine. This base possesses the power of dyeing silk a very clear golden-yellow color.

Picric or Dinitrophenic Acid.—This beautiful acid was discovered as early as 1788, by Hausmann. It may be obtained by the action of heated nitric acid on a great variety of substances; the following are the names of some of them:—indigo, aniline, carbolic acid, seligenine, seli-cylious and salicylic acids, salicin, phloridzin, cumarin, silk, aloes, and various gum resins, it is now prepared for commercial purposes from carbolic acid, and also from certain gum resins. I have prepared it from carbolic acid on the large scale, in the following manner, with success:—As strong nitric acid acts very violently when brought in contact with carbolic acid, I have found it best to use an acid having a gravity less than 1·3, so as partially to convert the carbolic acid, and afterwards to boil it in stronger acid, to change it into picric acid. On diluting the acid solution, the impure picric acid precipitates. To further purify this, it should be crystallized from boiling water. When preparing this product for commercial purposes, it is advantageous to let all the nitrous fumes formed in its preparation, together with a certain amount of atmospheric air, pass over a fresh quantity of carbolic acid. This will absorb them, and at the same time be converted into nitro, or dinitrophenic acid, and consequently diminish the quantity of nitric acid required for its manufacture. When preparing picric acid from carbolic acid, there is always a quantity of yellow, resinous matter produced, and at times a considerable quantity of oxalic acid. The latter is always produced when the acid which is used to finally convert the carbolic acid is too weak, for then it rapidly decomposes the picric acid, yielding carbonic and oxalic acid. Picric acid, when pure and dry, is of a light primrose-yellow color, crystallizing in strongly shining laminæ. It possesses an extremely bitter taste, and dissolves in water with a beautiful yellow color. When digested with protoxyd of iron in the cold, it yields a brown amorphous compound, which dissolves in water with a blood-red color. Picrate of copper is a beautiful yellowish-green color when in solution. If required

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for dyeing purposes, it may be prepared by mixing a solation of a picrate with sulphate of copper. Picric acid was introduced as a dye about five or six years since, by MM. Guinon, Marnas, and Bonney, eminent silk dyers of Lyons. Many of the cheap products sold as picric acid are of a brown color, and consist of impure di- and tri-nitrophenic acids, and sometimes of this crude product and ground turmeric.*

Rosolic acid.—Runge first noticed this substance in 1834, when studying creosote, but it was almost lost sight of until again observed by Dr. Hugo Müller only a short time since. He accidentally observed that when crude phenate of lime is exposed to a moist, heated atmosphere, as that of an ordinary drying-stove, it gradually changes in color, and assumes a dark-red tint. This coloration is owing to the formation of rosolate of lime. I have lately heard that phenate of soda undergoes a similar change. Dr. Müller prepared rosolic acid from this product in the following manner:—The crude rosolate of lime is first boiled with a solution of carbonate of ammonia. By this means a crimson solution, containing the rosolic acid, is obtained. This solution is then evaporated nearly to dryness, during which process ammonia is given off, and the crimson-colored liquid gradually changes to a yellowish-red, and at the same time a dark resinous matter separates. This resinous substance is crude rosolic acid. In order to purify it, it is submitted to the following treatment, proposed by Runge:—The crude rosolic acid is dissolved in alcohol, and hydrate of lime added in slight excess. The beautiful crimson solution which is thus formed is agitated for some time with the undissolved portion of the lime, filtered, and the filtrate diluted with water, and, lastly, the alcohol distilled off. The residuary rosolate of lime is then decomposed with just a sufficient quantity of acetic acid, and the whole boiled until every trace of free acetic acid and still adhering alcohol is volatilized. The rosolic acid separates first as a red precipitate, but, when heated, cakes together, forming a dark, brittle substance, having a greenish-metallic lustre.

It may be still further purified by solution in alcohol, to which a little hydrochloric acid has been added, and precipitation with water. Pure rosolic acid is a dark amorphous substance, possessing the greenish-metallic lustre of cantharides. Its powder is of a red, or rather scarlet, shade, which, if rubbed with a hard, smooth body, assumes a bright gold-like lustre. In thin layers, rosolic acid presents an orange color when viewed with transmitted light, but, with reflected light, a golden-metallic appearance. When thrown down from an alcoholic solution with water, it forms a flocculent precipitate of a bright-red color, resembling the basic chromate of lead. Concentrated acids, as acetic, hydrochloric and sulphuric, readily dissolve rosolic acid, forming brownish-yellow solutions, from which water precipitates this acid unchanged. To cold water, it imparts a bright-yellow color, and it is more soluble in hot than cold water. Alcohol and ether dissolve rosolic acid with great facility, forming orange or brownish-yellow solutions, which, on evaporation, leave it in an amorphous state. With ammonia, caustic alkalies, and caustic earths, it forms dark-red compounds, which dissolve with a magnificent red color. These compounds are very unstable. No precipitates are formed with aqueous

* See the papers of Mr. Lea on Picric acid and its derivatives, in the late volumes of this Journal.

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solutions of the rosolates, with the basic acetates of lead, or with any other metallic salt; nor is any carried down by alumina, or any other metallic oxyd. Dr. Müller made two combustions of rosolic acid, which yielded results that agree with the formula $C_{23}H_{22}O_4$. I and Mr. Duppa, when investigating some of the derivatives of acetic acid, found that when phenic and bromazetic acids were heated together at 120 centigrade, two products were formed, one possessing all the properties of rosolic acid, while the other had the character of brunolic acid. We also found that a mixture of iodine and carbolic acid, when heated with formic, acetic, butyric, or valerianic acids, produce rosolic acids, or a similar substance. A mixture of carbolic acid and iodine did not give a similar result; but a black solid, containing iodine. Rosolic acid has lately been prepared on a large scale, and employed for the purpose of printing muslins. I believe it was a rosolate of magnesia that was employed for that purpose. I do not think it is now used, having been replaced by the more beautiful coloring matter, fuchsine. It was fixed by means of albumen.

The Coloring Matters of Quinoline or Chinoline.—Chinoline is found associated with lepidine, cryptidine, and other of the higher nitrile bases, in the basic oils obtained from coal-tar, and also in the products obtained by distilling cinchonine with caustic alkalies. It was previously termed leucoline or quinoline; but the substance described under these two names was found to contain three or more distinct bases. These have been studied by C. Greville Williams, who has applied the name chinoline to the product which forms the principal part of the impure substance originally termed quinoline. The substance used for the production of coloring matters need not be pure chinoline, as that product originally termed quinoline is of sufficient purity for this purpose. Cinchonine appears to be the best source of chinoline, yielding, when distilled with excess of caustic alkali, 65 per cent of this body sufficiently pure for manufacturing purposes. Chinoline yields three coloring matters—a violet, a blue, and a green. The following is an account of their preparation by C. Greville Williams:—

"In order to procure the blue color, one part by weight of chinoline is to be boiled for ten minutes with one part and a half of iodid of amyle. The mixture, from being straw-colored, becomes deep reddish-brown, and solidifies, on cooling, to a mass of crystals. This product of the reaction is to be boiled for ten minutes with about six parts of water, and, when dissolved, filtered through paper. The filtered liquid is to be gently boiled in an enamelled iron pan over a small fire, and excess of ammonia gradually added. The ebullition may be prolonged with advantage for one hour, the evaporation of the liquid being compensated for by the gradual addition of weak solution of ammonia. The latter may be prepared by the admixture of equal volumes of ammonia, of the density of 0·880, and distilled water. The hour having elapsed, the whole is allowed to cool, when the color will almost entirely have precipitated, leaving the supernatant liquor nearly colorless. On pouring the fluid away (preferably through a filter, in order to retain floating particles of color), the dish will be found to contain resinous-looking masses, which dissolve readily in alcohol, yielding a rich purplish-blue solution, which may be filtered and kept for use.

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"The color prepared as above is, as has been said, of a purplish tint; but, if a purer blue be required, the following modification is to be resorted to. The filtered aqueous solution of hydriodate of amyle-chinoline, is as before, to be brought to the boiling temperature; but, instead of adding ammonia, a solution of caustic potash containing about one-fifth of its weight of solid potash is to be substituted. The addition is to be continued at intervals until three-fourths as much potash has been added as is equivalent to the iodine in the iodid of amyle used. The fluid may, after a quarter of an hour's ebullition, be filtered to separate the resinous color. The product is a gorgeous blue with scarcely any shade of red. On adding the other fourth of potash to the filtrate while gently boiling, a black mass will be precipitated containing all the red, which would otherwise have been mixed with the blue. This mass dissolves readily in alcohol, yielding a rich purple solution, containing, however, an excess of red. The alcoholic solution, on filtration, leaves on a filter a dark mass soluble in benzole, and as sometimes prepared, affording a brilliant emerald-green solution of great beauty. It is not always easy to obtain this green color."

The properties of chinoline violet, and chinoline blue are, as far as I have been able to understand, identical. They are resinous substances which present a coppery appearance by reflected light; but, when in very thin layers, appear of a violet or blue color by transmitted light. They are bases, and dissolved in acids, forming pale-red solutions, which ammonia restores to their original colors. They are slightly soluble in hot water. Tannin precipitates them from their aqueous solution, apparently forming an insoluble compound. Reducing agents do not affect their shade of color.

Of chinoline green, I know but little. Greville Williams describes it as having a brilliant emerald-green color of great beauty. I have observed that, when chlorine is passed through an alcoholic solution of chinoline blue, it changes into green; but whether this is the green spoken of by Williams, I am unable to state.

Naphthaline Colors.—The beautiful hydrocarbon, naphthaline, which has yielded such a long category of substances to the chemist, up to the present time has yielded nothing of practical importance to the dyer. From it the following colored derivatives have been obtained—namely, chloroxynaphthalic acid, perchloroxynaphthalic acid, carminaphtha, ninaphthalamine, nitrosonaphthaline, and naphthamein.

Chloroxynaphthalic and Perchloroxynaphthalic Acids.—These acids were discovered by Laurent. They are produced by digesting their chlorids—namely, the chlorid of chloroxynaphthyle and the chlorid of perchloroxynaphthyle—with an alcoholic solution of hydrate of potassa. They appear to be very difficult substances to obtain in quantity. I have not obtained satisfactory results when endeavoring to prepare them. They have the formula $C_{10}(H_5Cl)O_3$, and $C_{10}(HCl_5)O_3$, respectively. They are regarded with great interest, as being very closely allied with alizarine, the coloring matter of madder; in fact they are viewed as chloralizaric acid. That hypothesis is based upon the idea of alizarine having the formula $C_{10}H_6O_3$; but it happens, very unfortunately for this theory, that the formula of alizarine itself is still a disputed point. Chloroxynaphthalic acid is of a yellow color. It is insoluble in water,

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and difficultly soluble in boiling alcohol or ether; but it dissolves in concentrated sulphuric acid. This acid is a very sensitive test for alkalies, being changed to an orange-red by them. This may be shown by moistening paper with a weak alcoholic solution of this acid, dryiug it, and then exposing it to ammoniacal vapors. This will cause it to assume a red color.

The chloroxynaphthalates are described as possessing great beauty, and are of yellow, orange, or crimson colors. The potassium salt is of a red crimson color, and slightly soluble in water; the barium salt crystallizes in silky needles, having a golden reflection. The strontium, calcium, aluminum, and lead salts are of an orange color; the cadmium salt is a vermillion-colored precipitate; the copper and cobalt salts are crimson; and the mercury salt is of a red-brown color. I once dyed some silk with a small quantity of chloroxynaphthalate of ammonia, which I prepared, and found it to produce a good golden-yellow color, of great stability under the influence of light. Perchloroxynaphthalic acid is a yellow, crystalline body, insoluble in water, but soluble in alcohol and ether. With potash or ammonium, it forms insoluble salts of red or crimson color, of great beauty.

Carminaphtha.—This coloring matter was also discovered by Laurent. It is obtained by heating naphthaline with a solution of bichromate of potassa, and then adding sulphuric or hydrochloric acid. It is described as a fine red substance, soluble in alkalies, but precipitated from its alkaline solutions by means of acids. I have never obtained this product when oxydizing naphthaline.

Ninaphthalamine.—Ninaphthalamine is a name which has been given to a remarkable base which was noticed by Laurent and Zinin; but nothing was known of its nature until re-subjected to investigation by Mr. Wood, who has both described and analyzed it, and some of its salts. Its formula is $C_{10}(H_8NO)N$, or naphthalamine, in which H is replaced by NO. Mr. Wood prepares this base in the following manner:—Sulphuretted hydrogen is to be passed through a boiling solution of dinitronaphthaline in weak alcoholic ammonia until nearly all the alcohol has distilled off, which operation should occupy two or three hours. The residue is then to be boiled with dilute sulphuric acid, and filtered. The filtrate, on cooling, deposits an impure sulphate of ninaphthalamine in the form of brownish crystals, which are purified by recrystallization in water two or three times. I have found when crystallizing this salt, that it is best to use water acidulated with sulphuric acid. When pure, this sulphate has to be decomposed with ammonia, and the resulting precipitate of ninaphthalamine washed with water. Thus obtained, ninaphthalamine appears as a bright red-colored crystalline precipitate, which, when viewed under a lens, appears as beautiful needles. It is very soluble in alcohol, producing a solution, which, when dilute, is of an orange color slightly tinged with brown, not nearly so pure in color as that of nitrophenylenediamine. It is slightly soluble in water, and possesses the power of dyeing silk with a color somewhat similar to that of ordinary annata. With acids, it produces colorless salts. Its formula is the same as that of nitroso-naphthaline, though it possesses very different properties. As a dyeing agent, I do not think it would be of any value, even if it could be obtained cheaply.

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Nitroso-naphthaline.—This peculiar body is a product of the action of nitrous acid on naphthalamine. It is prepared by mixing a solution of hydrochlorate of naphthalamine with nitrate of potassa. From this mixture it separates as a reddish-brown precipitate. This, when washed with water on a filter and then dried, is dissolved in alcohol, filtered and evaporated to dryness on the water-bath. Thus prepared, it is a crystalline, dark-colored substance, having a greenish-metallic reflection. It is soluble in alcohol, and also in benzole, forming orange-red solutions. When acids are added to an alcoholic solution of nitroso-naphthaline, it immediately assumes a most beautiful violet color, as fine as any aniline purple. Alkalies restore it to its original color. Silk may be dyed a beautiful purple shade with this substance, provided a certain quantity of hydrochloric acid, or sulphuric acid, be present. But what is most unfortunate is, that when the silk thus dyed is rinsed in water, the color immediately passes back to that of the pure nitroso-naphthaline, and also that the amount of acid required to keep up the purple shade, if left in the silk, rots it in a few days. Could this purple be fixed, nitroso-naphthaline would be a cheap and most useful dye. I have endeavored to produce the sulpho-acid of nitroso-naphthaline, thinking that if such a compound could be obtained, it would possess a purple color because it would be an acid itself. But, although sulphuric acid does dissolve it, forming a blue solution, yet no combination takes place. I also endeavored to produce this desired result by treating sulpho-naphthalamic acid with nitrous acid, but obtained only nitroso-naphthaline, the acid of the sulpho-naphthalamic acid having, apparently, separated.

Naphthamein.—Piria observed that naphthalamine and its salts produced blue precipitates, afterwards becoming purple, when brought in contact with perchlorid or iron, terchlorid of gold, nitrate of silver, and other oxydizing agents. This product of oxydation, he terms naphthamein. It is prepared by adding a solution of perchlorid of iron to a solution of hydrochlorate of naphthamein. This mixture gradually changes and becomes blue, and after the lapse of a short time deposits a blue precipitate. This, when separated by means of a filter, is washed with water, which causes it to change in color until of a reddish-brown purple. The filtrate from this substance contains protochlorid of iron, and, according to Piria, chlorid of ammonium. Naphthamein, when heated, fuses and decomposes, leaving a residue of charcoal behind. It is insoluble in water, sparingly soluble in alcohol, but more soluble in ether. It forms a blue solution with concentrated sulphuric acid, and is reprecipitated from it by water. It dissolves in concentrated acetic acid with a purple color, and is not precipitated from this solution by means of water. Silk and cotton may be dyed with it, but the color of this compound is so inferior as to render it useless as a dyeing agent.

Tar Red.—This coloring matter was discovered by Mr. Clift, of Manchester, in 1853. It is obtained by exposing a mixture of the more volatile parts of the basic oils of coal-tar and hypochlorite of lime to the air for about three weeks. Of the pure coloring matter I know nothing, except that, with tannin, it forms an insoluble, or difficultly-soluble, substance. With different mordants, it yields different colors. It seems probable that this coloring matter is derived from pyrrole.

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Azuline.—This substance, which is a beautiful blue dye, has been introduced within the last six months. It was discovered by MM. Guinon, Marnas, and Bonney, of Lyons, who keep the process for its preparation a secret. It is obtained from coal-tar, but from which of its numerous derivatives is not known. This coloring matter is a brittle, uncrystallizable body, possessing a coppery, metallic reflection. It is very difficultly soluble in water, but soluble in alcohol, producing a magnificent blue solution, having but a slight tinge of red. With concentrated sulphuric acid it forms a blood-red liquid, which, when poured into an excess of water, precipitates the coloring matter unchanged. Dilute acids have no effect upon azuline. Its alcoholic solution, when mixed with an alcoholic solution of hydrate of potassa, also changes to a dull-red color. This, when diluted with water, forms a purple liquid, which is gradually restored to its original blue color by hydrochloric acid. With excess of ammonia, the solutions of azuline change to a reddish-purple color. This ammoniacal solution, when treated with sulphid of ammonium, gradually assumes a dull, yellowish-brown color. Iodine destroys the color of azuline. In color, it is not quite so fine as chinoline blue, though far superior to Prussian blue.

[The remarks of Mr. Perkin on the methods of applying coal-tar colors in the arts of dyeing and calico printing we omit, as all who are interested in the methods will seek fuller details in the dye-house.—Eds.]

Application of Nitrosonaphthaline.—If cloth is printed with a thickened solution of a salt of naphthalamine, dried, and then passed through a solution of nitrate of potassa, nitrosonaphthaline will rapidly make its appearance as a reddish-orange color; but, unfortunately, the color thus obtained will not well resist the action of soap.

Of the numerous coloring matters of which I have briefly spoken, there are only four that are at present employed by the dyer and printer, namely, aniline purple, fuchsine, picric acid, and azuline; but I think it probable that others of them will soon be introduced, such as the bleu de Paris; and nitrophenylene diamine might be used for silk-dyeing, as its color is good and it stands the action of light well. Unfortunately, the chinoline colors, though very beautiful, are most fugitive. There has been an endeavor to introduce the chinoline blue of late; but, although a considerable quantity of silk was dyed with it at first, it is now scarcely used, because, when exposed to the sun for two or three hours, the dyed silk becomes bleached. Aniline purple resists the light best. Fuchsine and alpha aniline purple soon fade, especially when on cotton. Azuline and bleu de Paris are not easily acted upon by light when on silk.

When the coloring matters of coal-tar were first introduced, there was a great fear that the workmen engaged in their manufacture would suffer in health. All I can say is that, during the few years I have had to do with this branch of manufacture, there has not been a single case of illness among the workmen that has been produced by any operations carried on for the production of aniline purple.

[*Note.*—To the reader desirous of consulting a more detailed account of "the Coloring Matters derived from Coal-Tar" than is contained in Mr. Perkin's instructive lecture, we would commend a series of papers, *Sur la Préparation des matières colorantes artificielles*, by Prof. Émile

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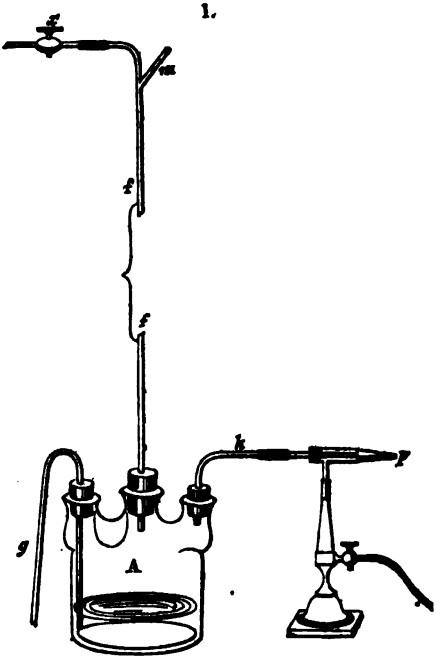
Kopp, which have been published during the past year in Quesneville's *Moniteur Scientifique.* Not only do these articles furnish to the professed chemist a complete historical and critical account of the subject, but they also contain a full discussion of its technical details. Since the very completeness of Kopp's memoirs must necessarily preclude the idea of transcribing them to our pages, we would here once for all call attention to their excellence.]

11. *Blast for Laboratory use.*—Dr. H. Sprengel has devised a combination of the Catalan-trompe and Maugham's burner which appears to merit the attention of all chemists who have at command an abundant supply of falling water and street gas.

The author specially insists upon an apparatus intended as a substitute for the common mouth blowpipe, but remarks that it may be modified so that it can serve to heat crucibles, for the fusion of silicates, etc.

In fig. 1 the cock x controls the supply of water falling down the tube f in which it mixes with air drawn in through the side tube m. The tube f should be from 1 to 1½ metres long [1 metre = 39·37 inches] and from 6 to 8 millimetres wide, the syphon g being of similar diameter. The capacity of the flask A is about 1 litre [1 quart = 1·14 litre]; it must be provided with tightly fitting corks. Water being allowed to flow by opening the cock x, a mixture of air and water reaches the flask A in which separation occurs, the water flowing out through the syphon g while air is forced out of the tube k by the pressure of the new portions of water and air arriving by f. The current of air flowing through k is conducted to the centre of a flame of street gas burning, at p, from the opening of a Maugham's burner.

1.



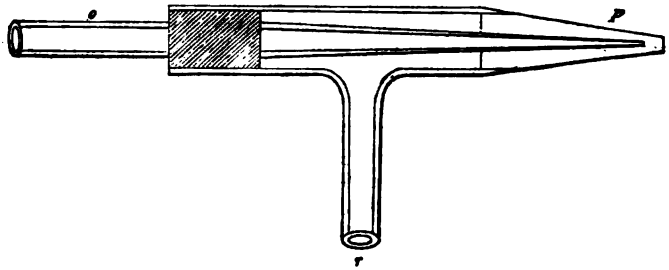
The arrangement of the burner may be seen more clearly in fig. 2. The gas enters at r, the air at o.

The conical tip p of the external tube is of platinum foil, but the other portions are of glass, including the interior tube which is fastened to the other by means of a cork. Special care is necessary in finishing the tip since the beauty and regular form of the flame depends upon the uniformity of the fine opening.

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The amount of water to be employed depends of course upon circumstances. With an apparatus of the given dimensions from 25 to 70 litres

2.



of it were used according as the flame was of moderate size, or the apparatus driven to its utmost capacity.—(Poggendorff's *Annalen*, cxii, 634).

PHOTOGRAPHY.—

12. *A rapid Collodion.*—The "Photographic Notes" publishes the following formula for a collodion ten times more rapid than ordinary collodion, which is copied without comment in the Moniteur de la Photographie.

Plain collodion, - - -	30 grammes.
Acetate of soda, - - - -	0·250 "
Iodid of cadmium, - - -	0·250 "

This formula we have carefully tried and in our hands it proved absolutely worthless. E. E.

13. *A rapid dry process.*—Le Moniteur de la Photographie for August gives a formula of Mr. Roman de Wesserling modifying *Taupenot's process* and giving a dry collodion process as rapid as the wet process.

It is essential to have a gun-cotton which gives a transparent collodion, and one also which is able to resist the repeated washings. The collodion must be neutral. The ether ought to be sp. gr. 0·732 and should not redden litmus paper, even after long immersion.

For landscapes, and copying, a thick collodion is first made as follows—

1·5 gramme gun-cotton.
90 cubic centimeters ether sp. gr. 0·732.
10 " " alcohol 95 per ct.

Of this thick collodion take 40 parts and add

35 parts ether, sp. gr. 0·732.
25 " alcohol 95 per ct. containing
0·250 grammes iodid of ammonium.
0·250 " " cadmium.

For portraits the formula is varied, viz.—

1 gramme gun-cotton.
90 parts sulph. ether sp. gr. 0·732.
10 " alcohol 95 per ct.

Carefully filter the collodion, then take

50 parts of this thick collodion,
25 " alcohol containing 5 per ct. iodid of cadmium.
10 " " " " bromid of cadmium.
15 " ether sp. gr. 0·732.

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The sensitizing bath is

6 grammes pure nitrate of silver
100 " " water.

Albumenize with

110 grammes albumen.
50 " water.
·050 " iodid of ammonium.
·025 " bromid of ammonium.

Shortly before exposing the plate it is again sensitized in a bath composed of—

8 grammes pure nitrate of silver.
8 " glacial acetic acid.
100 centimeters pure water.

It is afterwards slowly dipped in fresh water and set up in a dark place to dry.

After exposure develop by a bath of—

100 grammes water.
0·5 " pyrogallic acid.
10 " acetic acid.

This developing bath should be heated to 120° Fah. Strengthen by re-development with pyrogallic acid. Fix as usual. E. E.

II. GEOLOGY.

1. *On the Taconic System of Dr. Emmons;* by T. Sterry Hunt, M.A., F.R.S.—Dr. Emmons while engaged in the survey of a part of the State of New York, recognized the existence of a series of sedimentary rocks, which he described under the name of the Taconic system, and regarded as older than those supposed by his colleagues to represent the Silurian series. A similar view had been maintained by Eaton, but was rejected by most of the American geologists, who up to this time have regarded these Taconic rocks of Emmons as belonging to the Lower Silurian series. In 1844 Dr. Emmons described certain fossils from these rocks, which he supposed to be new and to distinguish what he called the Taconic system, regarded by him as the true palæozoic base. In 1846 Mr. Barrande discovered in Bohemia, beneath the horizon of the hitherto recognized Silurian fossils, a new and extensive fauna in what he designated the Primordial Zone. The fossils described by Dr. Emmons consisted, besides some imperfect trilobites, of a few graptolites, mistaken by him for fucoids, and several very doubtful forms which are valueless for the purpose of determination. According to Dr. Emmons this system, which he divides into an upper and lower portion, has a thickness of 30,000 feet, and extends throughout the whole Appalachian chain. He has described it as composed in ascending order of, 1. Granular quartz. 2. The Stockbridge limestone. 3. Magnesian slates. 4. Sparry limestone. 5. Roofing slates (graptolitic). 6. Silicious conglomerate. 7. Taconic slates. 8. Black slates. This is not their apparent order of superposition, but Dr. Emmons conceives that the whole series has been inverted since its deposition. In fact the schistose strata 5, 6, 7 and 8, pass successively beneath the magnesian slates and limestones, which in their turn are overlaid to the east by the

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Green Mountain gneiss. This latter formation Dr. Emmons regards as a primitive azoic rock, upon which were successively deposited the members of the Taconic system, commencing with the quartzite, which forms its base, and crowned by the black and Taconic slates, which are now, from an immense overturn, placed at the bottom of the series, while the ancient gneiss lies at the top. It is hardly necessary to say that this supposition is wholly unwarranted by the facts. In a paper on American geology already cited we have shown that the apparent succession of the rocks of the Quebec group is the true one. The black slates are really at its base and successively overlaid by the conglomerates, roofing slates, limestones and quartzites, and the gneiss is a newer rock, being no other than the Sillery sandstone in an altered condition, and as we have there shewn, entirely distinct from the Laurentian gneiss. Mr. Emmons has fallen into an error, similar to that of Prof. Nichol with regard to the gneiss of the Scottish Highlands, so well refuted by Murchison, Ramsay and Harkness, and has consequently been driven, in order to explain the structure of the Green Mts. to admit not merely an upthrow with Nichol, but a complete overturn of the whole palæozoic series in question. As to the geological age of this series, Dr. Emmons maintains that his Taconic system occupies a position inferior to the Champlain division of the New York system, and is consequently beneath the Lower Silurian system of Murchison. As we have before shown, however, the fossils of the Quebec group show it to be the palæontological equivalent of the Calciferous sandrock. The Stockbridge and sparry limestones, with their accompanying slates (excepting only 7 and 8,) we conceive to be no other than the Quebec group, of which they have both the stratigraphical position and the lithological characters. Dr. Emmons has maintained that limestones of the age of the Calciferous are found overlying the black slates, and has appealed to this in proof of the antiquity of the whole series, of which he imagined these slates to form the summit, but inasmuch as these slates are really older than the Quebec or Calciferous strata, his argument falls to the ground. Mr. Billings has lately found *Conocephalites* in the red sandrock of Highgate, Vermont, which is supposed to overlie the black slates in question. As this primordial genus occurs also in the Potsdam sandstone of Lake Champlain, the question arises whether these slates are palæontologically distinct from the Potsdam, or are only its deep sea equivalent, sustaining to the littoral formation of quartzose sandstone on Lake Champlain, the same relation as the great Quebec group does to the Calciferous sandrock of the New York geologists. Dr. Emmons claims that the whole of his Taconic system is inferior to the Potsdam sandstone, which is the admitted base of the Champlain division, but we have already shown that the whole of his system, with the probable exception of these slates, is of the age of the Calciferous sandrock, the second member of that division.* Unless then these lower black slates contain a fauna distinct from and older than that of the Potsdam sandstone, there remains absolutely nothing of the Taconic system which Dr. Emmons placed below the base of the Champlain division, that is to say, below the Potsdam sandstone. If, however, as is probable, these slates contain a fauna distinct from the Potsdam, they might be retained under the name of the

* This Journal, May, 1861, p. 401.

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Taconic formation, as a lower member of the Primordial Zone, to which the Potsdam sandstone unquestionably belongs.

These lower slates in Georgia, Vt., have as already remarked, furnished certain trilobites of primordial type which Mr. James Hall has described under the name of *Olenus Vermontana* and *Olenus Thompsoni*, though they are provisionally referred by Barrande to the genus *Paradoxides*. In the meantime the only trilobite as yet met with in the typical Potsdam sandstone of this region, which is rarely fossiliferous, is *Conocephalites*.* A collection of fossils recently made by Mr. James Richardson in exploring the Straits of Bellisle for the Geological Survey of Canada, fortunately furnishes the means of determining the relations of the trilobites described by Mr. Hall. On the north side of the Straits he found reposing on the Laurentian rocks a coarse reddish sandstone holding *Scolithus* like that from the Primal sandstone of Pennsylvania. Resting upon this, and dipping gently southward, is a limestone in which occur both *Olenus Thompsoni* and *O. Vermontana*, with what appears to be an *Arionellus*, besides *Obolus*, *Capulus*, and a large spirally marked coral resembling *Zaphrentis*. These rocks, which evidently represent the Primordial Zone, are overlaid by others containing the characteristic fossils of the Calciferous sandrock and the compound graptolites of the Quebec group. These primordial trilobites then overlie the sandstone with *Scolithus*, but as we have elsewhere observed, that species appears unlike the *Scolithus* from the Potsdam of Lake Champlain, and should not be too much relied upon for fixing the geological age of this formation. It is not improbable that the true equivalent of the Conocephalites and Lingula sandstones of Lake Champlain will be found in some of the strata above the Olenus beds of Bellisle.

We have seen that Emmons, guided by a false notion of the age of the Green Mountain gneiss which led him to admit an inversion of the whole series, placed the shales which form a portion of the Primordial Zone high in the second fauna, above the whole Quebec group. On an entirely different ground, Hall assigned the shale containing *Olenus*—two species of which genus he described in 1847 in the 1st Vol. of the Palæontology of New York,—to the Hudson group. In this, as Barrande shows, Mr. Hall felt himself justified by the authority of Hisinger, who in his great work on the fossils of Sweden, *Lethæa Suecica*, 1837, gives the succession of palæozoic rocks in Sweden as follows in ascending order; 1. Fucoidal sandstone; 2. Orthoceratite limestone; 3. Alum slates with *Olenus*; 4. Argillaceous slates with graptolites, etc.

The *Olenus* slates, said by Hisinger to overlie the orthoceratite limestone, (corresponding to the Trenton,) Mr. Hall unhesitatingly regarded as the equivalents of the Hudson group, in which *Olenus* was to be looked for as a characteristic fossil, and hence the strata containing these trilobites were, on the authority of Hisinger, regarded as belonging to the summit of the second fauna. In reality however this order assigned by Hisinger to the formations of Sweden is false, since the alum slate with *Olenus* lies

* Mr. Barrande refers to three species of *Dikellocephalus* indicated by Dr. Bigsby as occurring in the Potsdam of New York. It will be seen by referring to his memoir (Quar. Jour. Geol. Soc. 1858, p. 339, compared with p. 420,) that Dr. B. alludes only to the existence of these species as described by Owen in the Mississippi valley.

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below, and the graptolitic slate above the orthoceratite limestone. This error of Hisinger is the more strange since he had long before, as Barrande shows, indicated the true succession of these rocks, and it is perhaps a mistake of the copyist or printer; it is the more to be regretted as his authority had caused it to be adopted by Mr. Hall in America. (*Geol. of Lake Superior, Foster and Whitney*, II, pp. 298–318.) The alum slate with the underlying sandstone represents in Sweden the primordial zone.

To Dr. Emmons undoubtedly belongs the merit of having recognized for the first time the trilobites which are known to belong to the primordial zone, although from incorrect notions of stratigraphy he placed the slates containing them at the summit of the series of rocks to which he gave the name of the Taconic system. We have shown that the true place of these shales is at the base of the series, and that the remainder of the Taconic system is the palæontological equivalent of the Calciferous sandrock; it is not yet certain whether these lower shales with a primordial fauna do not sustain a similar relation to the Potsdam sandstone, in which case the whole of the Taconic system would be the equivalent of the two lower groups of the Champlain division. It yet remains to be seen whether Dr. Emmons can retain from the wreck of his system, the lower slates as a Taconic formation older than the Potsdam sandstone of Lake Champlain, and subordinate to the Primordial Zone, whose fossils he was the first to recognize.

2. *Contributions to Palæontology*, being Descriptions of New Species of Fossils from the Upper Helderberg, Hamilton and Chemung Groups. Albany. August and September, 1861. 8vo. pp. 84.—We have received this valuable paper at too late an hour for critical notice in our present issue. It is, as the Author states in a prefatory note, "A Continuation of Appendix C of the Fourteenth Annual Report of the Regents of the State Cabinet, published July, 1861, and contains descriptions of new species of GASTEROPODA, CEPHALOPODA and CRUSTACEA, with notices of some of the species before described from the same strata."

"The first twenty-four pages were published and distributed in August, and the remaining portion is published in September according to the imprint at the bottom of each page. The entire paper, with illustrations, will be republished in the Fifteenth Annual Report of the Regents of the State Cabinet; and the Author will endeavor to furnish those who may receive the accompanying pages, with a copy of the illustrations when published." JAMES HALL.

Albany, Sept., 1861.

This is as it should be. The criticisms we took the liberty to make on the Thirteenth Annual Report and its Palæontological Supplement (see this Jour., [2] xxxi, p. 292), were based upon the want of precisely this definite statement of dates of publication. It will be satisfactory to all naturalists to know that the suggestion has been met so promptly by this distinguished Palæontologist. We shall take another occasion to discuss the contents of Prof. Hall's memoir, as well as the 14th Annual Report of the Regents of State Cabinet. The first twenty pages of the Appendix C in which, form as above stated a part of Prof. Hall's Contributions.

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III. ZOOLOGY.

1. *Synopsis of a Course of Lectures given at the Museum of Natural History (Paris), in* 1850; by M. ISIDORE GEOFFROY SAINT-HILAIRE.*

[The following synopsis, although by no means new, will be read with interest at the present time in connection with the recent discussions on the origin of species, especially as it is not generally accessible to American students.]

ON SPECIES.

I. *On the Animal Series, and the Parallellic Classification.*

(1.) The various zoological types may be reduced to a serial or progressive order.

(2.) The principle of coördination of the series resides essentially, not as was vaguely said before the time of Lamarck in the greater or less *perfection* or *complication* of organization, but in its *diversification*, *specialization* and *centralization*, which are at the maximum at one extremity of the series, at the minimum at the other.

Thus, at the top, the beings whose apparatus, organs, and tissues are the most *diversified*, whose functions are the most *specialized*, whose organism is the most *centralized:* at the bottom, the beings whose composition is the most *homogeneous*, in whom the functions are the most completely confounded, and the life, in some sort *diffused*.

(3.) In the animal series, sometimes the terms succeed each other at very close intervals, occasionally even, without sensible interval; sometimes two consecutive series remain at a great distance from each other.

The series is then neither *regular* nor *continuous*.

(4.) Neither is it *simple*. Often, and even most usually, it is double, triple, or more complex still, successions of terms manifestly analogous being found in two or several groups otherwise distinct. These successions of analogous, or as they would be better called, *homologous* terms in different groups, are what we have named *parallel series*.

(5.) Hence arise double relations which it is important to know and to express. Great attention has always been paid to the *affinities* which unite the *varied types* comprised in the *same group;* the knowledge of the affinities which *bind together* the *homologous types* existing in *different groups*, is not less necessary to the rational conception of the series and to the expression of their natural connections.

(6.) This expression, it has seemed to us, can be given by the new system of classification, known as the *parallellic classification*, or classification by *parallel series*, which is on the whole, but a very simple improvement on the system usually employed.

Suppose a group *n*, comprising several secondary types which we shall designate by the letters *A*, *B*, *C*, *D*, *E*.

Suppose another group *N*, holding the relations with the first which we have just indicated, that is to say, of which the secondary types are homologous to the preceding. We shall call them, to express at once the *continued* difference and the homology, *a*, *b*, *c*, *d*, *e*.

Suppose a third group **n**, giving similarly a, b, c, d, e. A fourth N, giving A, B, C, D, E, and so on.

* Translated for this Journal by a lady.

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It is manifest that the expression of the multiplied relations, existing between all these terms will be obtained, if on the one hand, the terms of each series, *A*, *B*, *C*, &c., *a*, *b*, *c*, &c., follow each other without the intercalation of any foreign term; and on the other, if the homologous terms of the various series, *A*, *a*, a, *B*, *b*, b, &c., are placed in apposition to each other. The parallellic classification satisfies these two conditions by the following combination, simple enough to be seized at a glance:

A	*a*	a	A
B	*b*	b	B
C	*c*	c	C
D	*d*	d	D
E	*e*	e	E
F	*f*	f	F*

(7.) There exist, so to speak, parallelisms of all degrees. The species of one and the same genus, the genera of one and the same family, often form parallel series; it is sometimes thus (to go no higher) with the classes of the same branch. The word *type*, just now employed, may then receive any given value, provided that by *group* is understood a division of the degree immediately superior.

The *parallellic classification* has been, for eighteen years, (in 1850) applied by various authors to the greater part of the branches of Zoology, Anthropology, Feratology and Botany.

II. *Summary of lessons on the question of species.*

(1.) The characters of *species* are not *absolutely fixed*, as many have said, still less indefinitely varied, as others have maintained. They are fixed for each species, so long as it is perpetuated in the midst of the same circumstances. They become modified if the surrounding circumstance change.

(2.) In the latter case, the new characters of the species are, so to speak, the *resultant* of two contrary forces; the one *modifying*, is the influence of the new surrounding circumstances; the other *conservative* of the type, is the hereditary tendency to reproduce the same characters from generation to generation.

In order that the *modifying influence* should predominate, in a very marked manner, over the *conservative tendency*, it is necessary then that a species should pass from the circumstances in the midst of which it was living, into a new and very different totality of circumstances; that it should change, as has been said, its *surrounding world*.

(3.) Hence the very narrow limits of the variations observed amongst wild animals.

Hence also the extreme variability of domestic animals.

(4.) Amongst the former, species remain generally in the places and the conditions where they are established, or remove from them as little as possible; for their organization is in harmony with these places and conditions, and would be in disagreement with other surrounding circumstances.

* For greater simplicity we have here supposed the four series equally extended, and without gaps. In reality it is scarcely ever so. For example, there might be *A*, *B*, *D*, *E*, *F*; *a*, *c*, *d*, *f*, &c. The series are not the less manifestly parallel, only, some terms remain without homologues.

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The same characters must then be transmitted from generation to generation.

Circumstances being permanent, species are so likewise.

(5.) Already, however, the permanence, the fixity are not absolute. The gradual expansion of a species on the surface of the globe is, at length, the necessary consequence of the multiplication of individuals. Other causes, of an order less general may also bring about partial displacements. Whence, especially at the limits of the geographical distribution of the species most extended, arise notable differences of habitat and climate, which, in their turn lead inevitably to secondary differences of regimen and even of habits. To these various kinds of differences correspond *races* characterized by modifications in color and other exterior characteristics, in proportion and form, and sometimes even in internal organization.

(These races have been arbitrarily considered, sometimes as *local varieties*, sometimes as distinct *species*).

(6.) Among domestic animals, the causes of variation are much more numerous and more potent. In a long series of experiments which, though undertaken with a merely practical object, have no small theoretic importance, species of various classes, to the number of about forty, have been constrained, by the intervention of man, to quit savage life, and bend to very different habits, regimen and climates. The effects obtained have been in proportion to the causes; there have been formed a multitude of very distinct races; amongst them several offer characters equal in value to those by which genera are commonly differentiated.

(7.) The return of many of the domestic races to the wild condition has taken place on various points of the globe: thence, a second series of experiments inverse to the preceding, and furnishing the counter-proof. If domesticated animals are replaced in the circumstances in the midst of which their wild ancestors existed, their descendants, after some generations, resume the characters of the latter. They only assume analogous characters if they are restored to savage life under conditions analogous, but not identical.

(8.) To resume: the *observation* of wild animals already demonstrates the *limited* variability of species.

The *experiments* on wild animals domesticated, and on domestic animals returned to the wild condition, demonstrate it more clearly still.

The same experiments prove, moreover, that the differences produced may be of *generic value.*

(9.) The truth or error of a doctrine may almost always be brought to light by the value of the consequences derived from it.

The *theory of limited variability* may lead to *rational* solutions with respect to questions completely insoluble for the partisans of absolutely fixity, or which the latter can only resolve by aid of the most complex and improbable hypotheses.

(10.) It is thus with the fundamental question of anthropology. The common origin of the various human races is *rationally* admissible in the point of view of variability, and *in this point of view alone.* In order to

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admit it with us, the partisans of *fixity* have been forced to conclude against their own principle.

(11.) In palæontology, to the theory of limited variability corresponds a simple and rational hypothesis, that of *filiation;* to the doctrine of fixity, two hypotheses equally complicated and improbable, that of *successive creations* and that called *translation.*

According to the hypothesis of *filiation*, the existing animals are sprung from *analogous* animals which have lived in the previous geological epoch. We may, for example, seek the ancestors of our elephants, rhinoceroses and crocodiles amongst the elephants, rhinoceroses and crocodiles of which palæontology has shown us the antediluvian existence.

This hypothesis has been rejected as irreconcilable with the *fixity* of species, because of the specific differences which exist between the ancient animals and their modern analogues. To the simple explanation of these differences by changes taking place, from one geological period to another, in surrounding circumstances, has been preferred the hypothesis of several *successive creations*, and, more recently, that of *translation.* To resume the example quoted above: these two hypotheses agree in admitting the complete extinction of the ancient species of elephants, rhinoceroses and crocodiles; but the first replaces them by the elephants, rhinoceroses and crocodiles of the *new creation;* the second, by the actual species, supposed to be pre-existant, with all their present characters, on some other point of the globe which had remained unknown. Of these three hypotheses, that which springs from the theory of variability is incontestably the most simple and least conjectural. For this reason, it may already be presented as the most probable.

(12.) But it has not alone this advantage over the others.

It can be, and is even now, verified in its application to various particular cases.*

(13.) Moreover, it is confirmed by various considerations in presence of which it seems difficult to maintain the other two hypotheses. Without insisting on that of *successive creations*, we shall confine ourselves to placing here in opposition, in two of their consequences, the hypothesis of *filiation* and that of *translation.*

(14.) According to the first, the existing animals should be descended from animals merely *analogous;* according to the second, from animals *similar* to themselves. Now the preservation of the *same characters at all periods*, would suppose the existence, *at all periods* also, of the *same* surrounding *circumstances*, which is *inadmissible.*

(15.) In the hypothesis of *filiation*, the number of species might vary, becoming greater or less from one geological period to another; for if at each revolution, there has been an extinction of a portion of the species, those which remain *must* have undergone modifications, various according to circumstances, and which *may* have acquired the value and permanence of specific characters. In the opposite hypothesis, at each revolution a portion of the species disappears; the others *remain what they were:* they are displaced, but without undergoing organic modifications. Consequently, the extinctions are here *without any possible compensation.* Then, according to this hypothesis, the number of animal and vegetable species must have gone on constantly decreasing; there would be a *pro-*

* Which has been demonstrated in the Course of Lectures of 1847.

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gressive diminution, a depopulation of the globe: the two hundred and sixty thousand animal and vegetable species which, according to the most recent estimations, now cover the surface of the earth, would be but the wrecks of a creation infinitely richer in past times.

Such is the consequence to which the hypotheses of absolute fixity and of translation naturally lead: each will judge how far it agrees with the notions that we possess on the ancient condition of the globe.

(16.) The substitution of the theory of *limited variability* for the hypothesis of absolute fixity renders necessary a new definition of species.

To approach as nearly as possible the definitions most in use, and for the moment, considering only the existing order of things, we shall say:

Species is a collection or succession of individuals characterized by a combination of distinctive features, the transmission of which is NATURAL, REGULAR *and* INDEFINITE *in the existing order of things.*

The possibility of distinction, the natural and regular transmission, stability and permanence equal to those of the present condition of the globe—such are the three essential elements of this definition of species.

A few words are necessary to explain the terms of it.

Hybrids are not generally unfruitful, as has often been said;* they can transmit their characters, *always mixed*. Hybrid races are not propagated with the constancy and regularity observed in species; they soon die out, or return by the effect of crossing, to one of the species whence they sprung. The transmission is then neither *regular* nor *indefinite*.

It is the same with monstrous or anomalous races.

Domestic races approach much more nearly to species. Amongst those which are very ancient, and which have thus acquired a great fixity, the transmission may even be said to be *regular;* it may be *indefinite*, and as durable as the existing order of things, but only by the intervention of man, which is necessary to maintain the races as it was to create them. The transmission is not then natural.

2. *On some Objects of Natural History from the Collection of Mr. Du Chaillu;* by Prof. OWEN.—Prof. Owen's first knowledge of the zoological collection was derived from a letter sent by Mr. Du Chaillu, dated Gaboon, June 13, 1859, and received in the British Museum in August, 1859, in which Mr. Du Chaillu specified the skins and skeletons of the gorilla or n'gena, kooloo-kamba, nschiego, and nschiegombovie which he had collected, offering them for sale, with other varieties, to the British Museum. Prof. Owen replied, recommending the transmission of the collection to London for inspection, with which recommendation Mr. Du Chaillu complied, bringing with him all the varieties he had named, with other objects of natural history, from which he permitted selection to be made. The skins of the adult male and female of the young of the *Troglodytes gorilla*, afforded ample evidence of the true coloration of the species. In the male, the rufo-griseous hair extends over the scalp and nape, terminating in a point upon the back. The prevalent grey color, produced by alternate fuscous and light grey annulations of each hair, extends over the back, the hair becoming longer upon the nates and upon the thighs. The dark fuscous color gradually prevails as the hair extends down the leg to

* We have given proofs of this that cannot be refuted, by uniting in two tables the indications relative to hybrid Mammifers and Birds, and *to their products*.

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the ankle. The long hair of the arm and forearm presents the dark fuscous color; the same tint extends from below the axilla downwards and forwards upon the abdomen, where the darker tint contrasts with the lighter grey upon the back. The scanty hair of the cheeks and chin is dark; the pigment of the naked skin of the face is black. The breast is almost naked, and the hair is worn short or partially rubbed off across the back, over the upper border of the iliac bones, in consequence, as it appears, of the habit ascribed by Mr. Du Chaillu to the great male gorilla of keeping at the foot of a tree, resting its back against the trunk. The skin of the great male gorilla, as mounted in the British Museum, exhibits two opposite wounds,—the smaller in front on the left side of the chest, the larger close to the lower part of the right blade-bone. Two of the ribs in the skeleton of this animal are broken on the right side near where the charge had passed through the skin in its course outwards. These marks correspond with the account of the slaughter of the great gorilla given by Mr. Du Chaillu. Prof. Owen proceeded to describe the color of the female gorilla, which, it appears, was generally darker and of a more rufous tint than the male. In one female the rufous color so prevailed as to induce Mr. Du Chaillu to note it as a red-rumped variety. In the young male gorilla, 2 ft. 6 in. in height, 1 ft. 7 in. in the length of the head and trunk, and 11 inches across the shoulder, the calvarium is covered with a well dressed "skull-cap" of reddish colored hair. The back part of the head behind the ears, the temples and chin are clothed with that mixture of fuscous brown and grey hair which cover with a varying depth of tint the trunk, arms and thighs. The naked part of the skin of the face appears to have been black, or of a very dark leaden color; a few scattered straight hairs, mostly black, represent the eyebrows. A narrow moustache borders the upper lip, the whole of the lower lip and sides of the head are covered with hair of the prevailing grey fuscous color. The rich series of skulls and skeletons brought home by Mr. Du Chaillu illustrate some most important phases of dentition. These phases were specified by Prof. Owen at length. The deciduous or milk dentition, it was remarked, were in the youngest specimen of the gorilla something similar to those of the human child, but an interspace equal to half the breadth of the outer incisor divides that tooth from the canine, and the crown of the canine descends nearly two lines below that of the contiguous milk molar. The deciduous molars differed from those of the human child in the more pointed shape of the first, and much larger size of the second. The dentition of the young gorilla corresponds best with that exemplified in the human child between the eighth and tenth years; the difference, however, is shown in the complete placing of the true molar, whilst the premolar series is incomplete. It was worthy of remark, also, that in both specimens examined the premolars of the upper jaw had preceded those of the lower jaw, and that the hind premolar has come into place before the front one. In the later development of the canines and the earlier development of the second molars of the second dentition the gorilla differs, like the chimpanzee and the orang, from the human order of dental development and succession. An opportunity of observing this order in the lower races of mankind is rare. Prof. Owen availed himself of the opportunity in the case of the male and female dwarf Earthmen from

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South Africa, exhibited in London. He found dentition at the phase indicative of the age of from seven to nine in the English child; other indications agreed with this evidence of immaturity. The children were dressed and exhibited as adults. Both showed the same precedency in development of canines and premolars which obtains in the whole race. Referring next to the variety of the chimpanzee brought by Mr. Du Chaillu from the Camma Country and from near Cape Lopez, Prof. Owen remarked that this species accords specifically in its osteological and hirsute development with the *Troglodytes niger*. It is stated by Mr. Du Chaillu to be distinguished by the natives of Camma as the nschiegombovie from the common chimpanzee (*Troglodytes niger*), called by them the nschiego. From the character of the skins of the male and female specimens of this species brought by Mr. Du Chaillu to London, Prof. Owen would have deduced evidence of a distinct and well-defined variety of Troglodytes.—*Athenæum, Sept.* 14, 1861.

3. *On the Height of the Gorilla;* by Dr. J. E. Gray.—Much difference occurs in the statements of travellers and others with reference to the height of the great African ape. Bowdich, the first traveler by whom it was mentioned, under the name of *Ingēna*, states it, on the authority of the natives of the Gaboon, to be generally five feet high; but, in some recent notices, it has been asserted to reach the height of six feet two inches; and the specimen exhibited at the meeting of German naturalists at Vienna is said, on good authority, to have measured more than six feet in height. The measurement of a stuffed skin without bones is necessarily delusive, depending as it does, firstly on the mode in which the skin has been originally prepared, and, secondly, on the extent to which the artist may be disposed to stretch it. Such measurements are not to be relied on unless they are in accordance with those of the bony skeleton; and it, therefore, occurred to me that it would be desirable to measure the long bones of the limbs of the different skeletons existing in the British Museum, the osseous structure giving the only certain dimensions on which reliance can be placed. The skeletons in the British Museum are six in number, viz: 1. A skeleton, obtained from Paris by Prof. Owen, and mounted in the best French manner. 2, 3, 4. Skeletons of male, female and young, purchased from Mr. Du Chaillu. 5. A skeleton of a male, purchased at Bristol, of which we have also the stuffed skin. 6. An imperfect skeleton, purchased from M. Parzudaki, of Paris.

	Humerus.	Ulna.	Radius.	Femur.	Tibia.	Fibula.
	Measurement in inches.					
Articulated specimen from Paris,	17	14	13	14½	11½	10½
Skeleton from Du Chaillu's stuffed specimen (called the "King of the Gorillas"),	16½	14	13¼	13¾	11	9¾
Skeleton of young male, from the specimen purchased at Bristol,	14½		11	15		9½
Imperfect skeleton, purchased of M. Parzudaki,	12	11	10	11		9½
Skeleton of female, purchased of Mr. Du Chaillu,	13	11	10¼	11	9	7
Skeleton of young male, purchased of Mr. Du Chaillu,	12	11½	9½	10	8½	7

The measurements of the several bones of each of these skeletons are given in the accompanying table.

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They were taken by Mr. Gerard with a tape measuring inches and quarters of inches only, but are quite sufficient for a comparison between the specimens themselves, and as affording materials for determining the actual height of the animal. As the largest of these (viz., the Paris specimen, photographed for the Trustees of the British Museum by Mr. Fenton) stands five feet two inches in height, we are justified in concluding that to be in all probability the extreme natural height of the full grown animal.—*Athenæum, Sept.* 14, p. 348.

4. *Cambridge Museum of Comparative Zoology.*—The labors of Prof. Agassiz and the intelligent patronage of the Commonwealth of Massachusetts in establishing the new Museum of Comparative Zoology at Cambride, have found an appreciative eulogist in Prof. Owen in his recent communications to the London Athenæum, on the importance of establishing in London a national museum of Natural History. Prof. Owen had estimated the area required for such a museum as he contemplates, with a forecast of thirty years accessions, to be not less than five acres of land, and he is agreeably confirmed in this estimate by finding that this area is the same allotted at Cambridge to our new museum. We had marked this whole communication for extract, but cannot find space for it at present. Prof. Agassiz in a late letter says, "I am now hard at work perfecting the internal arrangement of the collections which begin to outgrow my strength. We want an *addition* to the present building larger than it is, for more than half the specimens on hand are not yet exhibited."

IV. ASTRONOMY AND METEOROLOGY.

1. *Discovery of the 71st Asteroid.*—August 13, 1861, about 11^h, M. Luther at Bilk near Dusseldorf discovered a new asteroid which appeared as a star of the 11th magnitude, making the number of asteroids now known 71. Its daily motion was $-16'$ in Right Ascension, and $+2'$ in Declination. It was observed at Bonn on the 15th, and at Mannheim on the 17th of August. This planet has been named Niobe.

2. *Re-discovery of Pseudo-Daphne.*—August 27, 1861, M. Goldschmidt of Paris re-discovered the planet which he discovered Sept. 9, 1857, and which has received the name of Pseudo-Daphne. The history of this planet is very remarkable. On the 22d of May, 1856, M. Goldschmidt of Paris, discovered a new planet of the 11th or 12th magnitude. He observed it again on the 25th, but on neither occasion was he able to locate the planet accurately for want of suitable instruments. On the 31st it was observed at Marseilles; it was observed at Berlin, June 1, 2, and 3d, and it was observed at Vienna, June 2d and 4th. The planet being now quite faint and difficult to observe, was no longer followed; so that the reliable observations only embrace an interval of *four days*, and the arc described in this interval was but little more than *one degree*. From this small arc it was required to deduce the elements and compute an ephemeris for the planet's return to opposition in Sept. 1857.

M. Pape of the Altona Observatory computed the best orbit he was able from these observations, and published an ephemeris for the approaching opposition. Anticipating the difficulty of finding the planet, the astronomers at Oxford, Paris, Berlin, Vienna, Altona and Bilk agreed upon a joint search, each observer selecting a portion of the heavens which he would specially explore.

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Sept. 9th, 1857, M. Goldschmidt of Paris announced that he had rediscovered Daphne, only about two degrees from the place assigned by the elements of Pape. The planet was afterwards observed at Bilk, Leyden, Bonn, Berlin and Cambridge, and was followed till Sept. 30th. On computing the orbit from the observations of 1857, it was found that the elements differed very materially from those which M. Pape had obtained; and indeed these new elements would not represent the places of Daphne in 1856, within more than 12 degrees. This discrepancy was first announced by M. Schubert, in Sept. 1858; and he of course concluded that the planet discovered by Goldschmidt Sept. 9th, 1857, and which was supposed to be Daphne, was *not* Daphne, but a new planet. M. Goldschmidt accordingly gave the new planet the name of *Pseudo-Daphne.*

M. Luther at Bilk made a careful computation of the orbit of Pseudo-Daphne, and published an ephemeris for the next opposition in December, 1858, but *the planet was not found.*

M. Luther again computed the planet's place for the succeeding opposition in March, 1860; but as, on account of its distance, its brightness should be only one-fourth of its brightness in Sept. 1857, there was not much encouragement to prosecute the search, and the planet was not seen in 1860. He however remarked that at the next opposition in August, 1861, the planet should appear of the 10.11th magnitude, or somewhat brighter than in 1857, and he accordingly published an ephemeris to guide astronomers in their search for it. The planet was discovered by M. Goldschmidt Aug. 27th, 1861,

in R. A. $20^h\ 25^m\ 5^s$ Dec. $-6°\ 48'\ 5''$.

Its place according to the elements of Luther should have been

in R. A. $21^h\ 2^m\ 12^s$ Dec. $-4°\ 49'{\cdot}5$.

The observed place therefore differed from the computed place

in R. A. $36^m\ 16^s$ Dec. $2°\ 0'$.

or about ten degrees in arc. This error is not very great, when it is considered that the planet's place was computed from an arc of *less than four degrees, described four years previous.* It is presumed that Pseudo-Daphne will not again escape from the watchful eye of astronomers; but Daphne seems entirely lost, and can only be re-discovered by the same systematic search by which it was discovered in 1856.

3. *Comet* II, 1861. (Continued from p. 165).—Captain Earle of the ship Jireh Swift reports that the comet was seen from the ship in lat. 34° 19′ S. long. 179° 55′ E. on the 18th of May.

On the 25th the tail was 10° long, and on the 26th 15° with a slight curve, the round side being presented to the N.E. Time $5^h\ 10^m$ P. M. lat. 50° 43′ S, long. 163° 8′ W.

G. P. Bond,
Director of the Observatory of Harvard Coll.

From the Astronomische Nachrichten, No. 1324, we learn that the comet was seen at the Observatory of Sydney, New South Wales, on the 13th of May. On the 27th of May the comet was but just visible to the naked eye. On the 8th of June, it was very conspicuous to the naked eye, being equal to a star of the fourth magnitude. It continued to increase in brilliancy, and on the 21st of June, the tail subtended an angle of about 18°.

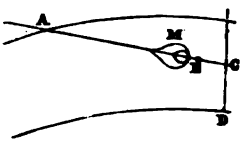
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METEOROLOGY.—

4. *Notices of Meteoric Masses;* by Director HAIDINGER.—Below we give additional abstracts of Director Haidinger's recent papers on meteoric subjects and intend to publish in the January number of this Journal a more complete account on the nature of meteorites by the same author.

The following additions and explanations to the abstracts already published in this volume, p. 135, are given in a letter of Director Haidinger to Dr. Genth, dated Dornbach, near Vienna, July 31st, 1861.

"The stone of *Pegu* [(5) page 143], is *no other than that* of the fall at Quenggouk, near Bassein in Pegu, on December 27th, 1857, page 142. My excellent friend, Mr. Oldham, Superintendent of the Geological Survey of India, sent the first specimen with only the locality, *Pegu*, because at that time he had not yet received the more accurate notices respecting the fall. But I was not willing to keep back the first account of all the Calcutta meteorites, till I received more detailed information, because I could not depend upon receiving it by a given day, and so I gave it with the year of discovery, 1854, merely by guess. When Mr. Oldham sent the additional notices I corrected my first erroneous statement in the memoir 'on the falls of Quenggouk and Dhurmsala.' But there is still another point relating to the Quenggouk fall and meteorites, very properly adverted to in Prof. Silliman's note, page 139. I had inferred from Mr. Oldham's letter, that the specimen he sent to us, weighing 1 lb ¼ loths, was one of the aerolites, quite entire, just in the condition in which it had fallen. This specimen was only partially crusted over. But it now appears I was mistaken in this, as from a later communication I learned that it was only *a fragment* of a larger meteorite, which weighed 4 lbs 1 oz. 30 grs. Then likely enough, this aerolite was also crusted over the whole surface. As yet I have no answer to a definite question put to him, but I am convinced that the third stone of those which fell, was also crusted all over. The question of a thinner crust covering a part of the surface of aerolites is also adverted to in one of my papers —read July 5th, 1860, II, Einige neuere Nachrichten über Meteoriten, namentlich die von Bokkeveld, New Concord, *Trenzano*, &c., particularly as related to that of Trenzano, page 570, note. If an aerolite should happen to burst at the point C, the end of its cosmic course, it may indeed have a thin crust formed in the very moment of bursting. The slowness of the telluric course or real fall, the downfall, will not present the same probability. But if in the diagram above, the arresting of the meteor should not take place in one single point only, but with several fits or starts as it were and with several reports too, or when either particles by scaling off or a stone bursting perhaps at B, before the whole cosmic course in the atmosphere AC be completed, then there might remain room enough in the space between B and C to have a new and thinner crust formed, and particularly also a sufficient degree of velocity, though already near the end of the cosmic impulse. I find that this paper of mine has never been sent to Prof. Silliman. I enclose it now here and beg you will kindly add it to the collection. * * * *



With the kindest regards and many thanks again, ever most truly yours,

WM. HAIDINGER.

P. S.—I must still add another explanation relative to the movement of the Quenggouk-Pegu meteor. At first it was not quite clear, where the starlike appearance had originated, I mean in what quarter of the compass. "If" it appeared in E.N.E. first and then had gone down to the eastward, it must have first come in the direction W.S.W.! Now I wrote again to Mr. Oldham on the subject and had from him the decided reply that the meteor, when seen from the steam-frigate Semiramis, was moving, as nearly as could be remembered, *from W.N.W. to the Eastward.* This would give a course much less violently curved and crooked and indeed much more natural and probable. Mr. Oldham intended to have some additional questions put in order to ascertain the position still more exactly if possible.

This is another very great desideratum in the history of meteorites, the question which quarter of cosmic space they come from, the motion of each of the meteors

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being conceived to take place in a straight line with a velocity such as is observed or calculated from data, but this is a most difficult subject, though in some cases at least not altogether impossible of solution.

The Parnallee stone of 28th Feb., 1857, came nearly from the constellation of the Fishes;—I gave some notice of that meteorite in our meeting of Academy of the 4th of July; of a new aerolite, or rather one not yet described, in the Government Central Museum at Madras, which fell Jan. 24, 1852 I gave some notice on the 20th of June, as also on the 8th of April and 6th of June, notices of large masses of meteoric iron, found near Melbourne, Victoria, two of them valued at about 1½ ton, one 5 to 6 tons from the Dandenong ranges and near Western-Port. W. H.

1. Meteors resembling that remarkable one, observed on July 20th, 1860,* over a space of more than 1000 miles, from Lake Michigan to Long Island, are of rare occurrence. Notice of an analogous one was given by Dir. W. Haidinger at the meeting of the Imperial Acad. at Vienna of February 7th, 1861.

This was observed by Dr. Gustave Tschermak, immediately after sunset about 7½ o'clock, some evening in August, 1848 or 1849 at Littau, N.W. of Olmütz, in Moravia, as two fireballs or rather distinctly pear-shaped meteors of the greatest brilliancy, the first about three times as large as the area of the moon and larger than the second. He observed them at an altitude of about 11° in W.S.W., moving towards S.W. and disappearing at about 5° above the horizon behind a little house. The phenomenon lasted about 15 seconds; no sound was heard.

Several analogous phenomena are mentioned in Chladni's work, "*Ueber Feuer-meteore.*"

Before the year 1800 only two, and these, not very accurate accounts are recorded, the first of five fireballs, which are said to have fallen a few days after the 30th of November or (according to others) on the 12th of December, 1642, between Gran and Ofen; the second was noticed by the Duc de Guise,† who saw on the 8th of January, 1648, one fire-ball separate into three parts, which afterwards re-united.

Hardly belonging to this class are the two small fireballs, about twice as large as Venus, which were observed in the middle of August, 1800, at 9 P. M. near Halle, moving in a southwesterly direction, because the second appeared five minutes after the first, corresponding in the orbit of the earth to a distance of 6000 miles.

The phenomenon of April 15th, 1804, at 9¾ P. M., shows more analogy with the case of July 20, 1861. Luminous points followed this (1804) meteor moving somewhat downwards from S. to N.; another was observed at Göttingen, Sept. 16th, 1815, after 9 P. M. where eight or ten smaller ones followed a fireball in the same direction.

Still greater similarity was shown by the brilliant fireball of July 17th, 1818, between 9 and 10 P. M., as seen at Montpellier, Vermont.‡ A pear-shaped ball of the size of full moon with its broader end towards the earth, having the appearance of a solid body, and immediately followed by two smaller fireballs.

Arago§ gives in his list a phenomenon, the fireball of Collioure, Dept. of East Pyrenees of February 21st, 1846, consisting of two large lumin-

* This Jour., [2], vol. xxx, 293.
† Memoires du Duc de Guise, 2d ed., Paris, 1668, p. 328
‡ Journal of Science of Roy. Inst. Lond., No. xi, vol. vi, p. 160.
§ Populäre Astronomie, herausgegeben von Dr. W. G. Hankel, 1859, p. 219.

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ous balls, almost touching each other and moving from N.E. towards S.W. Also another one* of Aug. 12th, 1850, which according to Coulvier Gravier consisted of small balls.

2. At the same meeting Dir. W. Haidinger gives some details of the fall of the meteoric stones of Parnallee, near Madura in Hindostan, of which the smaller piece is in possession of the Western Reserve College at Hudson, Ohio, containing according to the analysis of Dr. Cassels (this vol., p. 402), 3 per cent of metallic iron and 17 per cent of nickel.

Mr. H. S. Taylor, chief of the American mission at Madura, gave in the transactions of the Geographical Society at Bombay in 1857, the first notice of the fall of two very large stones, one of 37 lbs, the other four times that weight. The larger stone is in the Madras museum, the smaller has been sent to Hudson, Ohio.

According to the report of Mr. Taylor, these stones fell a little S.E. of the village of Parnallee, 9° 14′ N. lat., and 78° 21′ E. of Greenwich, the larger a few seconds before the smaller and two to three miles north of it. From the direction of the hole, which they produced by their fall, they came from about N. 10° W., making with the perpendicular an angle of from 15° to 20°, the small one almost perpendicularly. The most rounded convex part, in which the centre of gravity lay, was lowermost in the earth. The larger mass penetrated the ground two feet five inches, the smaller two feet eight inches; the latter has *not* the appearance of being a fragment of the former.

According to Taylor the smaller stone has a spec. grav. of 3·3, a little higher, if soaked in water. (See Dr. Cassel's results.)

After having been wetted the larger piece showed a crack, which afterwards, perhaps by oxydation, increased in size.

The fall was accompanied by two terrible reports, resembling thunder claps. They were heard at Tuticorin on the coast of the Gulf of Manaar, 40 miles south, and very loud at Madura, 16 miles distant. Although several persons stood in the neighborhood, where the fall took place, neither of the stones was seen falling; a cloud of dust rose from where they struck. Their shape is compared with cannon-balls of large calibre, round, although somewhat irregular, with a black smoky crust, the interior resembling granite with particles of iron.

3. For about seven years it has been known that several huge masses of iron existed near Western-Port, southeast of Melbourne, in Australia, their meteoric origin however, was first suggested by Mr. Fitzgibbon. Several data relating to them obtained from a letter of G. Neumayer, Director of the Flagstaff Observatory to Prof. von Hochstetter, were communicated at the meeting of the Imperial Academy of Vienna of April 18th, 1861, by Director W. Haidinger.

The larger mass weighs from five to six tons, the other about 1½ tons. They are covered with a crust of the well known constitution, in which the usual cavities are not wanting. The relative situation of the two masses is N. 20° E., and they are about three and a half miles apart.

Both masses lie near the surface, so deep that only their tops project above the ground. The tertiary sandstone, occurring at Broughton, is also found there and basalt at the depth of from 12 to 15 feet just as

* Loc. cit., p. 224.

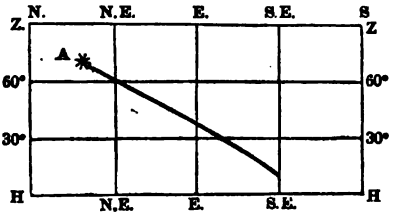
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on the coast at Western-Port. The small block lies in 38° 8′, the larger in 38° 11′ S. (about 145° 15′ E. of Greenwich), the first 107 feet, the second 127 feet above tidewater.

The masses showed no polarity, except that resulting from the earth's magnetism. The lower end of both pieces was a strong south pole, the upper a strong north pole; the longitudinal axis of the large piece, which is about five feet long, lies exactly in the magnetic meridian of the locality. It is the intention to bring the smaller mass to Melbourne.

4. On the occasion of the departure of Theodore von Heuglin to his travels in Africa, Dir. W. Haidinger made some suggestions with regard to observations during the journey, of meteors and meteoric stones or irons, whether recent or of former periods.

The observations are to be noted with as much accuracy as possible upon tables, on which hemioramas are prepared after the manner of Mercator's projection. The annexed sketch for example, represents a fireball, A, which appears at N.N.E. at an altitude of 70°, and goes down in a straight line to 10° S.E. The following points are to be taken into consideration.



(1.) The exact geographical situation; the situation as respects the constellations is not necessary, because that always can be found from the geographical position and the time.

(2.) Statement of time—hour, day, month and year.

(3.) Size compared with that of the full moon.

(4.) Form, whether round, pear-shaped, and in what direction, etc.

(5.) It is very important to notice, whether the meteor was first seen as a *star*, constantly increasing in size.

(6.) Duration of the phenomenon.

(7.) Whether it disappears like a star or in its full size, with statements of any additional circumstances.

(8.) Colors.

(9.) Phenomena of sound.

(10.) Circumstances connected with the fall itself.

(11.) Whether the material consists of iron or stone or any other substance.

(12.) Whether the fallen body is glowing or hot, or warm, perhaps warm on the surface, whilst cold inside.

It is of the greatest importance to collect and send on such substances; but since iron-masses are often very large and heavy, fragments ought to be taken, with careful drawings and measurements of the whole mass.

F. A. Gth.

5. *Remarkable Meteor, Oct.* 4, 1861.—On Friday, Oct. 4, 1861, at $7^h\ 20^m$ P. M., a brilliant meteor was seen at New Haven, shooting overhead from W. to E., and leaving a long bright track, from Cygnus to Cassiopeia, which was visible at least 120 seconds, slowly assuming a serpentine form. It was also seen at Litchfield, Conn., with like appearances.

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[REMARK.—The following paper by Prof. Twining was received too late to find its proper place among the original memoirs. But as it contains suggestions of much importance applicable to the succeeding return of the November meteoric shower, it seems proper to publish it without delay.—*Eds.*]

6. *Observations respecting the Periodic Meteors of August;* by ALEX. C. TWINING.

Upon every occurrence of the August meteors, which I have noticed with critical attention, my observations have been directed especially to the position of the "Radiant." Of the conclusions arrived at there are two of special interest:—

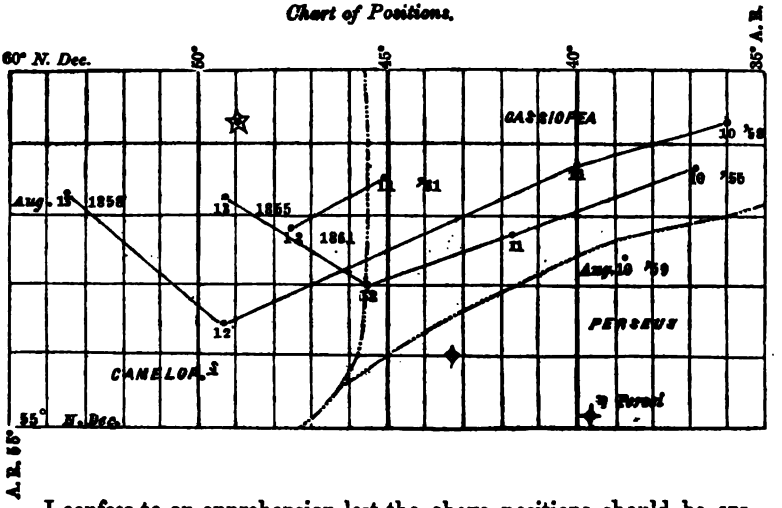
First; The position of the radiant is probably capable of a far more exact determination than is ordinarily supposed, or than could have been anticipated.

Second; The radiant is apparently subject to a motion of several degrees from day to day, and one which exhibits some remarkable points of agreement in the comparison of one year's positions with those of other years.

The accompanying fragmentary plane chart will illustrate these conclusions in detail. Upon it are projected lines of declination and right ascension, with the position of a few stars—all taken graphically from the North Polar Star Chart of the British Society for the Diffusion of Useful Knowledge. My observed positions of the radiant are also given by a minute circular disc, together with the year and the day of the month for each position. I have also distinguished the positions of each year considered as a series or group by tracing a fine line consecutively from position to position. By this grouping of the observations into distinct series, the eye will at once discern the correspondence, or want of correspondence, in the position and motions of the several years. It should be observed that the positions were determined in different localities in different years. The observations of 1855 were made at New Haven, those of 1858 at Cleveland, Ohio; that of 1859 at Boston, and those of 1861 again at New Haven. Whether this variation of localities has varied the groups or series compared with the same as they would have been seen from one and the same point of observation, is a question which I am inclined to answer in the negative, but not with entire confidence. Undoubtedly parallels and meridians and the time of day will affect the radiant positions unless the primary relative velocity of the meteors and the earth is so great as to make that deviation of orbit which is consequent upon the earth's attraction not a large one. The times of day were not always the same for the positions in the chart; but they were always within either about half an hour earlier or three hours later than the initial instant of the morning whose date is applied to the position. Thus a position taken on the 10th may have been as early as 11½ P. M. of the 9th or as late as 3 A. M. of the 10th, —more frequently the latter than the former.

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Chart of Positions.



I confess to an apprehension lest the above positions should be suspected of having undergone some sort of empirical accommodation to bring them into correspondence. It is a fact however that my memory always dropped the results as soon as recorded, and the record was not at hand for consultation from year to year. Moreover, some of the series exhibit erratic changes which neither judgment nor imagination could be tempted to originate. I remark, in passing, that the positions were always determined by employing the best accessible star charts, and, although the charts were modern, their epoch may have varied among themselves a little—say not to exceed half a degree of position.

It is very clear that many of the meteors which are properly marked "conformable" do not describe a flight that can be traced back exactly to the radiant. It is also true that the "non-conformable" meteors often appear, in small numbers—three to five—to have a common point of divergence in some quite distant locality of the heavens. What then —it may be asked—*is* this "radiant" whose position can be marked so definitely. I reply—it is not a point of exact apparent divergence of all the conformable meteors, but it is such a point for the great mass or assemblage of them, so far as one observer can judge; and it is also, under the same visual limitation, the centre of that area within which the others would project back their lines or directions. The process by which it is found has been, in my own case, the following:—The first few meteors—say five to seven—determine the locality rudely. Fixing our attention primarily upon this locality we are soon supplied with some contiguous and very definite flights which cut the area in a line that can be traced and kept in mind. It may be that this line will be shifted laterally by other nearly parallel flights. We next look with interest for other flights crossing the first at right angles or at a large angle; and when a few such are obtained they limit our area to a narrow central space subject only to slight shiftings one way or another according to judgment continually and rigidly exercised in view of the successive

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flights which can be brought into comparison with it. These flights should not ordinarily be very distant from the central area. In fact the very *abbreviated* streaks almost in immediate proximity to the radiant are of special value in the determination or the verification. Occasionally, indeed, a meteor will show itself stationary in the very radiant itself. In the year 1855 on the night of Aug. 10th such a stationary meteor appeared and almost instantly disappeared in the spot to which my sight was directed—with a peculiar effect, as if a new fixed star had suddenly begun its existence and as suddenly ended it. Not many minutes after a second came and went with a like singular and bewildering effect; and while I was in the act of pointing out its exact position to a fellow observer (Mr. Francis Bradley) a third drew from us both a simultaneous exclamation. This remarkable consecution of a phenomenon against which there were so many chances, and against the repetition of which in such a brief space the chances were so many millions of millions, satisfied me that multitudes of undiscovered meteors were in play over us, but for some reason not seen except when their flight was directed exactly to the observer. If this was the fact a telescope *truly pointed to the radiant* would have discovered yet more stationary points of brightness. Such an attempt if successfully made and ascertained to be ordinarily practicable, would realize this remarkable advantage—that, by employing the telescopes of graduated instruments, *our radiant positions might be defined with certainty, and with some rude approach, at least, to astronomical accuracy.* For although varieties of direction obtain, yet there may be a preponderating number so nearly the same as to exhibit a point of great and sudden concentration—like the image of a star by a chromatic lens. I am not aware that any of the few telescopic researches hitherto made have been directed to such a study of the radiant.

The simple method above explained appears to me more accurate for a determination of the radiant, than it would be to map down every flight in course as it occurs,—because of the unavoidable errors in estimating arcual distances from the stars of reference—a very serious error in the direction of moderate flights, but one which does not at all enter into the directions traced back by the mind at the moment of the flight. But, for other purposes, the mapping is indispensable to completeness of observation and record.

For any considerable advance upon our present knowledge of meteors and meteoric rings, we are clearly dependent upon accurate, systematic and *concerted* observations. The enumeration of flights both conformable and unconformable, is very important;* but the three elements of *radiant position, changes in its position,* and of the *meteors' velocity,* are obviously of elementary and primary importance, because those determine the plane, the figure and the magnitude of the ring. Even a casual observation of the principal meteor of the last periodic display, made coincidently—although without concert—by Mr. E. C. Herrick and the writer at New Haven, and by Mr. Benj. V. Marsh at Burlington, New Jersey, has seemed decisive, upon even the rudest attention, that

* My own enumeration for August last, having been referred to among those reported by Mr. Herrick, in the last number of this Journal, are here given. The

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the meteors of November and the meteors of August are independent and distinct in their origin or source. Still beyond this, an accurate discussion of the observations may even develop and determine within near limits the *actual conditions of the great meteoric ring of August.* But this need not be pursued here; for, happily, this discussion has been undertaken by Prof. H. A. Newton of Yale College, whose results, if they appear, will doubtless test conclusively the correctness of these opinions. But the four elements above referred to—including numbers—do not exhaust the *desiderata;* among which may here be instanced the absolute height of the upper and lower extremities of the meteors' paths,—their specific phenomena of combustion and dissipation,—and their irregularities, intermissions, or rebounds, as well as explosions.

The circumstance that upon certain definite days in August of each year, and in November of many years, observers will surely be rewarded with abundant opportunities and subjects for their attention is, of itself, one inestimable encouragement to concert and assiduity. The writer has already ventured the opinion in this Journal,* that, beyond a definite limit of the earth's atmosphere proper, there exists a secondary or external atmosphere—possibly of aqueous vapor,—that in this external medium the shooting stars become visible,—and that a knowledge of its upper limit may be obtained by considering and comparing the upper limit of the meteors' paths. It has long been his *suspicion*, to say the least, that some of the irregularities or specialities in meteor's flights above referred to are to be explained by their encountering a sudden change of medium from a secondary or exterior atmosphere to the atmosphere proper.† But to

times are those of the place of observation, i. e., New Haven, Conn., the locality circular with a radius of 50° around the Radiant.

Saturday, Aug. 10th, 1861, $10^h\ 30^m$ P. M. began observing.

From $10^h\ 30^m$	to	$10^h\ 40^m$,	for this interval of time, one a minute.				
" "	"	$11^h\ 0$	12	conformable,	4	unconformable.	
" "	"	$12^h\ 0$	41	"	10	"	
" "	Aug. 11th,	1^h,	78	"	17	"	total, 95 in $2^h\ 30^m$.

Sunday, Aug. 11, at $9^h\ 30^m$ P. M., began observing.

From $9^h\ 30^m$	to	$10^h\ 0^m$,	4	conformable,	2	uncon.	
" "	"	$11^h\ 0^m$	17	"	7	"	
" "	"	$12^h\ 0^m$	36	"	11	"	total, 47 in $2^h\ 30^m$.

On Saturday as many as five showed curved or irregular flights. The 29th, near the zenith, surpassed all others in brilliance, and in the remarkable extent and duration of its train, which was visible one third of a minute or more, and faded gradually from the ends to the middle. Time of flight 1·2 seconds.

* Vol. xxvi, note to p. 20.

† I may be excused for here propounding the enquiry, which has been forced upon me by certain auroral phenomena, whether some of those phenomena,—clouds, arches and streamers—have not commonly their lower limit at the surface of the atmosphere proper and their upper at a secondary atmospheric limit, as above suggested. So long ago as 1835 this was forcibly suggested and made almost *visual* by the flat base, and horizontal motion exactly along its base, of the singular auroral cloud described by me in vol. xxxii [1], p. 217–219 of this Journal. Some auroral arches also by their first dense formation and fast motions diminishing in both respects and suddenly dissolving when almost stationary, confer a plausibility upon the conjecture that they are formed at a definite lower surface and expand or rise till they are dissipated at a definite higher limit.

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realize the best attainable completeness of observation and record, certain preparations and facilities are doubtless important,—for example,

First; The ability to estimate arcs correctly in their angular amount,—especially small arcs.

Second; Readiness in measuring minute intervals of time by a mental standard closely accurate to tenths of a second.*

Third; Familiarity with all stars of the first five magnitudes in the specific area over which the observer maintains his watch.

Returning for a moment to the above chart, it need only be added that the radiant positions indicated thereon, as well as the other topics above referred to, are brought forward in the expectation of eliciting like observations from others, and in the hope of somewhat exciting a new zeal and assiduity, especially with reference to the coming November meteors.

Note by the Editors.—The Connecticut Academy of Arts and Sciences have lately instituted a Committee (of which Prof. Twining is chairman) to invite coöperation in the observation of the November and August meteors. The Editors take this occasion to say that observations duly recorded and forwarded to the Academy will doubtless receive a merited attention and announcement. They should be addressed to the chairman.

7. *Grand Meteor of August* 10, 1861.—*The August ring of Meteors;* by H. A. Newton.—The observations of this meteor (pp. 294–5 of this volume) give interesting results. It was seen by Mr. Marsh at Burlington, N. J., (lat. N. 40° 5′, lon. W. 74° 52′ 40″), and by Prof. Twining and Mr. Herrick, at New Haven, (lat. N. 41° 18′, lon. W. 72° 55′ 25″).

Mr. Marsh says, "I was looking exactly in the direction of the meteor and had a perfectly satisfactory view of it, and during the visibility of the train (20 sec.) noted with all possible care its position among the stars. I concluded that the track was very nearly in the line of τ Persei and θ Persei, and the point of disappearance was about in a straight line joining β Persei and γ Andromedæ,—the length of the track being about equal to the distance between η and τ Persei. I continued my inspection of the region some time after the disappearance of the meteor in order to fix the track firmly in my mind. The meteor itself lasted only one or two seconds. The time was about $11^h\ 23^m$ P. M."

* I recommend for a standard the repetition of a selected sentence inaudibly, without motion of the organs except the tongue. The syllables are to mark tenths of a second each, and should be of equal ease in pronouncing, and either nine in number or nineteen accordingly as you measure by seconds or by double seconds. The initial instant of the phenomenon to be timed, forms the *epoch* or zero of measurement, and the syllables are to be repeated at a uniform rate acquired by practice with a seconds pendulum or other index. The last tenth of the second, or double second, is marked by enunciating "one" (called "un" to avoid hiatus),—in like manner the last tenth or end of the second, third, fourth, &c., second or double second is marked by "two," "three," &c., on to "ten." Thus we shall have measured ten seconds, or better, ten double seconds or twenty seconds.

A brief practice will evince to any one the accuracy with which the mind forms a conception of time, and a long and intermitted practice the persistence with which it retains the standard thus distinctly formed, even after disuse.

Again, in the instance of these brief and *unannounced* flights most observers will best apply their standard, not to the phenomenon itself, but, on the instant after, to the *conception* of its duration which is then vivid in the mind.

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Prof. Twining says, "The meteor described by Mr. B. V. Marsh as the most brilliant of the display is identified by myself by several coincidences.

1st. It was preëminently the most brilliant flight within my time of observation.

2d. The time at New Haven was a very few minutes before 11½ P. M.

3d. The duration of the train was timed by myself afterward from recollection, and was less than half a minute, and more than a quarter.

The following are my own observations of the meteor's flight:

1st. Its line was traced back critically to the radiant which I find I had marked on the star chart of the Society for the diffusion of Useful Knowledge at R. A. 45°, N. P. D. 31° 30′.

2d. The flight was timed carefully and was found 1·2 seconds. This may be relied upon as a near approximation, at least.

3d. The meteor began at a point distant about 64° of arc from my radiant. It passed within a few degrees of the Dolphin. Its beginning was—say a degree—S.W. of a star which probably was *e* Cygni. I did not record the position laterally, that is to say, from E. to W., but the above distance remains unaffected by that circumstance.

4th. Estimated by subsequent examinations of the heavens I call its length of flight 29°."

Mr. Herrick says, "While we were intently watching the meteors of August 10, 1861, each of the four observers looking at an altitude of about 60°, we were all startled, about half past eleven P. M., by a very brilliant flash. Instantly turning for the cause, we saw among the stars overhead a bright phosphoric bar, the meteor having already vanished. This bar, which I locate nearly as stated by Prof. Twining, remained visible without material change of place or shape about 20 seconds, by estimate. From all the circumstances of the case I infer that the time of the meteor's flight could not have exceeded one second."

These observations indicate a visible track of about 33 statute miles, with altitudes above the earth's surface of about 70, and 54, miles at the beginning and ending. Its course was conformable, and there is every reason to suppose that it was one of the August group of meteors.

If the time of flight is 1·2 seconds, the velocity is 27·5 miles a second. The resistance of the atmosphere is wholly unknown, and for it no definite allowance can be made. For the increase due to the earth's attraction, subtract 48 from the square of 27·5 and take the square root of the remainder, agreeable to the principle of conservation of living forces. Though not an exact process this gives a tolerable correction where the velocity is large. The result is 26·6 miles a second for the relative velocity of the meteor.

The well established fact that the meteors of August 9–11 move in paths which produced backward pass through a small region of the heavens, and that this region of emanation remains the same, or nearly the same, from year to year, implies:

1st. That the individual meteors are cosmical bodies;

2d. That they are permanent members of the solar system revolving about the sun in *elliptic* orbits;

3d. That the direction and velocity of the relative motion, and therefore of the absolute motion, of the individual bodies are nearly the same;

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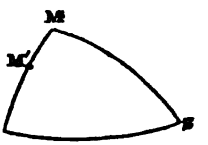
4th. That the whole group form what may be considered a ring, or disk, around the sun.

The region of emanation has not great length in the great circle through it and that point of the heavens to which the earth is moving. Hence the velocities of the individual meteors, of the same year, and of different years, are nearly the same.

The region of emanation has not great length in the great circle through it and the sun. Hence the tangents to the individual orbits make nearly the same angles with the sun's radius vector.

It follows that the elements of the individual orbits are nearly the same, and hence the probable conclusion that the meteors form a ring, and not a disk of great breadth in its own plane. If the breadth is very large, we must conclude that the great part of those orbits which cut the earth's orbit belong to a limited zone, or ring, in the disk. The mean velocity and direction of motion of the August meteors would give an elliptic orbit about the sun which would represent the ring. The velocity of a single member of the group and the mean place of the radiant, give approximate data for determining this orbit.

Let EMS be a triangle on the celestial sphere, E the point to which the earth is moving, S the sun's place, M′ the mean place of the radiant, and M the point from which the meteors are moving in their orbit around the sun. Since the motion from M′ is the resultant of the motions of the earth and the meteors, E, M′, and M, are in the same great circle. The place of M′ is found by observation, and if the mean value be taken there need be no correction for the earth's attraction. From the places of M′, and E, can be computed the angle E, and the arc EM′. ES can be called a quadrant.



Let v, v', and v'', represent the earth's velocity, the true, and the relative velocities of the meteors, v' and v'' being corrected for the earth's attraction. By the law of composition of motions $v'^2 = v^2 + v''^2 - 2vv''\cos \mathrm{EM}'$, and $v' \sin \mathrm{EM} = v'' \sin \mathrm{EM}'$. Also in the triangle ESM, $\cos \mathrm{SM} = \sin \mathrm{EM} \cos \mathrm{E}$, and $\tan \mathrm{S} = \sin \mathrm{E} \tan \mathrm{EM}$. But S (or $\pi - \mathrm{S}$) is the inclination of the ring to the ecliptic, and SM the angle which its tangent makes with the sun's radius vector. These with the value of v' give the elements of the ring.

Assuming M′ to be at R. A. 42°, N. P. D. 34°, E to be in the ecliptic at R. A. 46° 30′, v'' as above equal to 26·6, and v (including the earth's rotation) equal to 18·9 miles a second, we find,

EM′ = 39°,	v' = 16·8,	SM = 78°.
SEM = 78°,	EM = 84°,	ESM = 84°.

These give for the ring's semimajor axis 0·84, *for its ellipticity* 0·28, *its perihelion distance* 0·60, *its inclination* 96°, *and the periodic time* 281 *days.* The ellipticity cannot be less than cos SM, which is near 0·20.

The inclination of the ring to the ecliptic must be greater than 60°. For the greatest value of v' is 26·7 miles a second, that which belongs to a parabolic orbit. This with the radiant above assumed makes ESM > 65°. That ESM be less than 60°, the dec. of M′ must be reduced to 52° 40′, which appears hardly admissible. On the other hand to give ESM a value greater than 120° would require that v'' be less than 16·7, or the observed velocity less than 18 miles per second. The observations of Messrs.

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Herrick, Twining and Marsh, seem to render this also inadmissible. Until other determinations of velocity are made, 96°, as determined above, or 84° with retrograde motion, must be considered the most probable inclination. In any case *the meteors of the other known annual displays cannot proceed from this ring.*

The thickness of the ring is 5 to 10 millions of miles, for the earth, moving nearly two millions of miles a day, is immersed in it during several days. Some idea of its breadth could probably be obtained by observing the area of the region of emanation, or in other words, the average length of the perpendiculars from the centre of this area upon the paths, produced backward. Observations in the southern hemisphere from the 4th to the 8th of February are desirable, to determine whether the earth's orbit cuts the ring, or disk, at the other node.

A rude estimate of the number of individuals in the ring may be formed. Several observers in one place in the morning hours of Aug. 10–11 see at least 150 meteors, of which over three-fourths are conformable. Assume the average *perpendicular* distance of the paths of visible meteors from the observers to be not greater than 71 miles. This implies that not less than 112 meteors pass through a circle of 100 miles radius, the circle being at right angles to the relative motion. The velocity is so great that the earth's attraction is not of much account in making the number seen greater than the average throughout the ring. Reducing 112 by the ratio $v' : v''$, and calling the cross section of the stream not less than the area of a circle whose radius is 2,500,000 miles, we have at least $(2{,}500{,}000)^2 \times 112\ v' \div (100)^2 v''$ meteors passing the node per hour. In 281 days, the periodic time, we have more than 300,000,000,000,000 bodies for the whole August ring.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Return of the Arctic Expedition of Dr. Hayes.*—Dr. Hayes arrived at Halifax, N. S., on the 9th of October (and arrived at Boston, October 23d, 1861), with important additions to Arctic Geography, but disappointed as to the chief object of the Expedition. Science has to mourn the loss of the astronomer, August Sontag; the carpenter Gibson Caruthers also died during the voyage. Waiting the more exact account of his voyage which we look for from Dr. Hayes we quote meantime from the public journals the following notice of the voyage and its results.

The United States sailed from Boston July 10th, 1860. She reached Upernavik after a short but stormy passage and proceeded thence to Smith's Straits, where she remained until July 10, 1861.

On the 14th of April, however, a party left the vessel, consisting of thirteen men and sixteen dogs, with boats on sledges. The leader of this dog-train is now on board the United States, and is a fine specimen of the species. The party reached lat. 79° in the Middle Smith's Straits, and here the party divided—Dr. Hayes and three others went as far as lat. 81° 35′, west side of Kennedy Channel, (forty miles further northward than the latitude attained by Dr. Kane in 1854,) and were there obliged to put back, their provisions being exhausted. Dr. Hayes reached his vessel on the 27th of May. On the 13th of July, 1861, they proceeded to Littleton Island, where the vessel remained until the 27th. Sailing thence in a northerly direction they were met by immense packs of ice, which the

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vessel could not penetrate. She then made for Cape Isabella, on the west side of Smith's Straits, which was safely reached. Boat parties were sent out from here to explore, but the ice was so solid that no chance was found for proceeding. The United States next came to anchor at the Esquimaux settlement of Natik, Northumberland Island, on the coast of Greenland.

After surveying Whale Sound, the vessel sailed for Upernavik, on the voyage home, arriving there on the 15th August, 1861, after passing through one hundred and fifty miles of field ice in Melville Bay. She sailed thence for Discoe Island, and on the 17th September left for New York. From September 24 to October 7 the United States experienced very heavy gales, and sustained some slight injury to her sails and gear.

August Sontag, the astronomer, a gentleman of high scientific attainments, who accompanied Dr. Kane on his last expedition, and was at one time connected with the United States Coast Survey, was frozen to death in his sledge while out exploring, accompanied by a single Esquimaux. He had unfortunately driven upon thin ice which gave way, completely wetting him, and before he could reach a shelter was past recovery. The body was recovered and interred at Port Folke, near Cape Alexander.

The carpenter, Gibson Caruthers, died during the voyage. These are the only deaths out of the crew of sixteen persons which left Boston. The party was unusually free from sickness.

Six men belonging to the wrecked whaleship St. Andrew of Aberdeen, joined the United States at Discoe, making the crew twenty in number.

Hans, an Esquimaux, on whom Dr. Kane placed great dependence, who is frequently mentioned in Dr. Kane's book, and who deserted that expedition while in the ice in the far north, was found at Cape York by the crew of the United States, and returned in the vessel to Upernavik, whence he had started with Dr. Kane.

The expedition went as far north as 81° 35′, a latitude which is said to have been before reached only by Parry in 1827–8. On the coldest day experienced the thermometer fell to 68° below zero.

The vessel was provisioned for two years. The following is a correct list of those of the officers and crew of the U. S. who returned in the vessel:

Commander, I. I. Hayes, M. D.; Captain, S. J. McCormick; first mate, H. W. Dodge; second mate, John McDonald; commander's secretary, G. F. Khoor; assistant astronomer, H. D. Radcliffs; master's mate, Colin C. Starr; a cook, steward, cabin boy, and ten men before the mast.

At a dinner given to Dr. Hayes by the Medical Society at Halifax he made the following remarks:

"You have intimated to me, Mr. President, that a sketch of our voyage would be acceptable to the gentlemen who honor me with their courteous attention. We visited Smith Strait on the 26th of August of last year. Heavy ice and stormy gales prevented our penetrating far within the Strait; and after being twice in jeopardy among the bergs, and three times driven out of the Strait by northeast gales we were forced to go into winter quarters on the east side of the Strait, in latitude 78° 17′ S. I expected to have reached the west coast, and to have secured a harbor near latitude 80°. My plans of exploration were dependent upon dogs, of which an ample stock had been obtained in Southern Greenland. Most of these animals died during the winter, and I was

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obliged to take the field last spring with a weak force, and in an unfavorable position. I carried with me a boat mounted upon runners for service in the open sea to the northward. After a trial of nearly a month it was found that the boat could not be transported across the Strait, and I accordingly sent it back, and with three companions and two sledges drawn by dogs, I continued northward. On the 18th of May our provisions were exhausted and we returned, having reached latitude 81° 35′; a degree of Northing which I believe not to have been exceeded by any other person except Sir Edward Parry. The land which we explored is the nearest to the North Pole of any which is known. Beyond that land I believe there exists a perpetual open sea, which may be navigated. For this purpose, however, steam power is necessary.

It is my purpose to renew the attempt next year, if circumstances prove favorable; and I am still of the opinion that with steam power, a strong force of men and dogs, and a well organized system of advance depots, the North Pole can be reached. That the region about the Pole should be explored, you will I think all agree. It has long enough remained a terra incognita. Speaking as one interested in the advancement of science, I may say that I care not under what flag the enterprise may be conducted, whether that of America, or England, or France, Science will claim the honor of the achievement."

Dr. Hayes has succeeded in obtaining materials as extensive as could possibly be collected under the adverse circumstances of his voyage. Since the death of Mr. Sontag, the entire responsibility of pursuing the scientific experiments of the expedition has devolved upon Dr. Hayes, who has been a hard worker; and the results at which he has arrived show with what industry his investigations in the various departments of science have been pursued.

The chief results of the expedition are as follows: the completion of the survey of Smith's Sound; the discovery of a new channel at the westward of Smith's Strait; the confirmation of Dr. Kane's theory respecting an open polar sea; the determination of the magnetic dip, and of the declination at many points within the arctic circle; surveys of glaciers, by which their rate of movement is determined; pendulum experiments, and hydrographic surveys; a continuous set of meteorological observations; a large collection of specimens of natural history; a valuable collection of geological specimens; the accomplishment of a higher north latitude than ever before attained upon land; and lastly a large collection of photographic views of the country, icebergs and settlements of the natives.

The labors of the expedition have certainly not been in vain, and Dr. Hayes and his gallant companions are deserving of a generous welcome at the hands of the friends of science, and of Arctic exploration.

2. *The earthquake of 31st August.*—This earthquake was felt at the Washington Observatory at $5^h\ 22^m$ A. M. There were two marked shocks, each a succession of long waves of slight elevation, apparently proceeding from south to north. The interval between the shocks was perhaps five seconds. They were accompanied by the usual rumbling noise and were sufficiently severe to rock the water-ewer in its basin and jar the furniture of the chamber. The sound of the earthwave through the air continued audible some seconds after the tremor had ceased. To one who had

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experienced several hundred analogous phenomena of nearly every degree of violence, that of Saturday morning, Aug. 31, was unmistakable. J. M. G.

3. *Letter from C. Hitchcock, Esq., on the first observation on the fossils of the Red Sandstone formation of Vermont.*—Eds. Silliman's Journal: As a notice of the Conocephalites from the Red Sandrock series in Highgate, Vt., has appeared in your Journal, (Second Series, vol. xxxii, p. 232), it is but just to the dead to state who were the original discoverers of this trilobite. By referring to the Third Annual Rept. Geol. Vt., 1847, pages 14 and 31, it will appear that Prof. Z. Thompson conducted Prof. C. B. Adams to Highgate, where both gentlemen procured a large number of these trilobites. They were sent to Prof. J. Hall in 1847 for determination who gave them the name Conocephalus, the same genus to which Mr. Billings now refers them. At that time the precise position of the Conocephalus was not known. Nor was Prof. Hall able to give more definite information respecting them in 1858 when I showed him the specimens again.

These trilobites are noticed on pages 339 and 340 of our Third Report on the Geology of Vermont, which will be ready shortly for distribution.
Amherst, Mass., Oct. 23d, 1861.

[For Prof. Adams's own notice of the Champlain Division of the Taconic Rocks, see this Journal, [2], v, 109. We understand from Mr. Hunt that Mr. Billings has, since the date of his paper, here quoted by Mr. Hitchcock, seen Prof. Adams's remarks before the American Association, &c., at Boston in 1847, and quotes them in a paper now in press, indeed Mr. Billings has said the same to us in a late letter.—Eds.]

4. *Atlantic and Pacific Telegraph.*—The 28th of October witnessed the successful completion of the telegraphic connection of the Atlantic and Pacific Oceans by way of New York and Saint Louis to San Francisco and California. It is proposed to extend this line of communication to the mouth of the Amoor River, crossing Behrings Straits by a cable forty miles in length, and thus by way of the Russian lines to Central and Western Europe. About 1700 miles of wire it is said will accomplish this connection. We can then hope to receive our European and Asiatic news by way of the Pacific!

5. *Nicotine.*—It is stated that the tobacco crop of the world is 250 millions of kilogrammes (= 5,512,500 lbs. av.). Schlosing, as already quoted, this Journal, [1], iv, 273, found in various tobaccos an average of about 5 per cent of nicotine.

It is clear therefore that about twelve and a half millions of kilogrammes (=2,756,250 lbs.) of this poison are annually produced. As the sp. gr. of nicotine very slightly exceeds that of water, this quantity would fill nearly 100,000 wine barrels, and would give twelve and a half grammes (= 293·025 grains) to every man, woman and child on the globe. As a few drops will produce death, it is probably much within the mark to say, that one year's crop of nicotine could destroy every living creature on the face of the globe if its proportion was administered in a single dose.

6. *Geological Survey of Wisconsin.*—The report of the Survey of this State is in press under the supervision of Prof. James Hall. This volume, of 500 pages or more, will contain a chapter on the general geology,

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with a map, and full illustrations of the characteristic fossils of the several rock formations; also the elaborate report of Prof. J. D. Whitney, (now at the head of the geological survey of California,) on the lead region, with an enlarged sectional map showing the location of the mines, &c. Mr. T. J. Hale has been engaged during the past season making explorations under the direction of Prof. Hall, chiefly in the Northwestern counties.

The specimen of the plates of fossils which we have seen is very creditably executed in the best lithographic style.

7. *Eighty Years Progress of the United States, showing the various channels of Industry and Education, &c.* 2 vols. 8vo. pp. 457 and 455. New York, L. Stebbins, 51 John st. Compiled "by eminent Literary men."—This compendium of national statistics forms a valuable handbook of reference, to which all who possess it will have frequent occasion to turn for information in respect to the progress and condition of the great elements of growth and development in the history of the United States during eighty years past. The value of the book as a work of reference would have been much enhanced by a more frequent reference to authorities and original sources of information. But taken as it is, it supplies a great desideratum, and its pains-taking Editor, Mr. Stebbins, deserves our thanks for so valuable a contribution to our resources in this department of statistics.

8. *New American Cyclopedia*, vol. xiii, PARR—RED. Appleton & Co., New York, 1861.—This volume fully sustains the good character of its predecessors in the series.—*Photography*, by Dr. J. W. Draper, is a very interesting and instructive article. Of scientific articles, Parthenogenesis, Perpetual motion, Phosphorescence, Polarization, and Pneumatics, are furnished by Dr. Levi Reuben of New York; while Pearl, Perfume, Petroleum, Platinum, Pump and others are from Mr. J. E. Hodge. Prof. Parsons of Cambridge contributes a large number of learned articles on legal subjects. The article Persia, its Language and Literature, is from the learned pen of Prof. W. D. Whitney of Yale College. The article "Periodical Literature," by D. W. Fiske, Esq., of New York, is a comprehensive summary of that subject, and will be of the greatest importance to those seeking such information. Three volumes more we understand bring this series to a close.

9. *Personal.*—Prof. A. D. Bache, F.R.S., Superintendent of the Coast Survey of the U. S., was chosen Foreign Associate of the French Academy in the Section of Geography and Navigation in place of Mr. *W. Scoresby*, deceased.

Obituary.—Dr. Eli Ives died in New Haven, Oct. 8, 1861, at the age of eighty-two years. Dr. Ives was among the earliest of our botanists, and devoted himself particularly to the study of indigenous medicinal plants. He was the author of several botanical papers in the early volumes of this Journal. He was also an enthusiastic pomologist, and added several valued varieties to the cultivated Pears. He was one of the originators of the Medical Department of Yale College, and retained his connection with that Faculty for thirty-nine years. He was an eminently successful medical practitioner, and died at a good old age, universally beloved and honored by all who knew him.

Our list of publications received, and Proceedings of Scientific Societies, is unavoidably crowded over to an ensuing Number.

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